HP 5221B/5321B

PROJ. 30

OPERATING AND SERVICE MANUAL

ELECTRONIC COUNTERS

5221B AND 5321B

HEWLETT hp PACKARD

HP 5221A/5321A

CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

All Hewlett-Packard products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period. No other warranty is expressed or implied. We are not liable for consequential damages.

For any assistance contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

ELECTRONIC COUNTERS
5221B AND 5321B

5221B SERIALS PREFIXED: 744

This manual applies directly to HP Model 5221B Electronic Counters having serial prefix number 744.

5321B SERIALS PREFIXED: 812

This manual applies directly to HP Model 5321B Electronic Counters having serial prefix number 812.

SERIAL PREFIXES NOT LISTED

For later instruments with serial number prefix above those listed, a Manual Changes sheet is included with this manual.

OPTIONS

For instruments having option 01, refer to Section VII.

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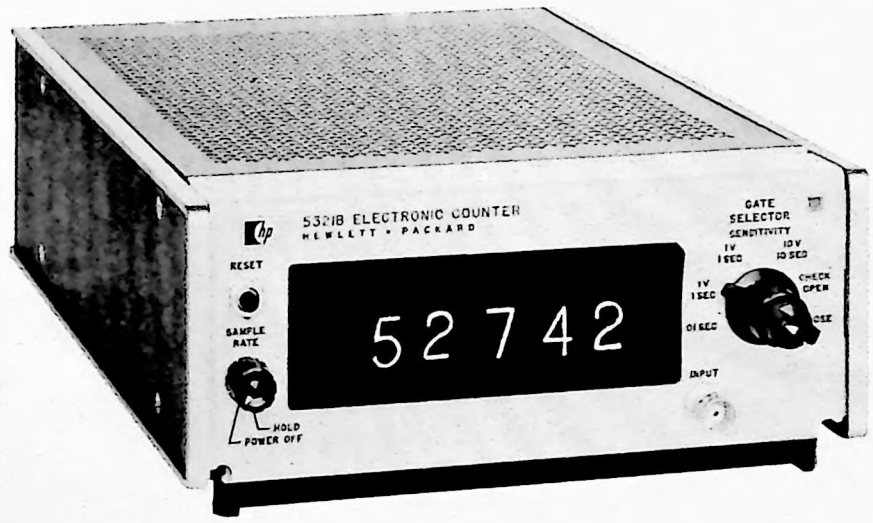
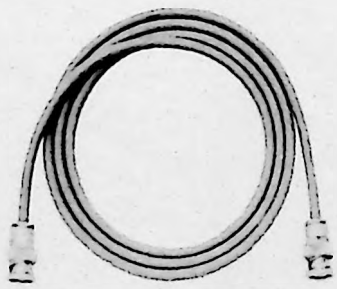
Figure 1-1. Models 5221B and 5321B and Accessories Supplied

MODEL 5221B

MODEL 5321B



BNC TO BNC CABLE



POWER CORD

SECTION I
GENERAL INFORMATION

1-1. DESCRIPTION

1-2. The Hewlett-Packard Model 5221B and 5321B Electronic Counters measure frequencies from 5 Hz to 10 MHz, the ratio of two frequencies, and time interval from 5 μs to 0.1 sec. Models 5221B and 5321B are electrically identical. The main differences are size and shape.

1-3. The Counters provide these additional features:

a. Blanking of unwanted zeros in the display (zeros left of the most significant digit).

b. Display storage holds the display while a new count is being made.

c. Remote gate control through BNC connector on rear panel.

d. Standard output frequency of 1 MHz.

e. Four-line BCD code gives decimal output of +8421 "1" state positive, for use with digital recorder.

1-4. The Counters feature solid state design using HP integrated circuits.

1-5. SPECIFICATIONS

1-6. Table 1-3 outlines the technical specifications for the Counters.

1-7. APPLICATIONS

1-8. The Counters can measure speed, rpm, rps, and count events occuring within a selected period of time. With transducers converting mechanical to electrical pheonomena, weight, pressure, temperature, and other quantities can be measured.

1-9. OPTIONS

1-10. The Counters are available with the following option: Option 01, 6 digit display.

1-11. INSTRUMENT IDENTIFICATION

1-12. Each instrument is identified by a two-section, eight-digit (xxx-xxxxx) serial number on the rear panel. The five-digit number is an identification number unique to each instrument, and the three-digit number is a serial prefix used to document changes.

1-13. All instruments with same serial prefix are the same. The group of instruments to which this manual applies directly is identified on the title page. For older instruments (lower serial numbers) make manual changes listed in Section VII. For newer instruments, having serial numbers higher than those listed on the title page, a Manual Changes sheet is included, describing the required manual changes. The manual for an instrument having special electrical modification will include an insert sheet describing that modification. If a change sheet or special information sheet is missing, the information can be supplied on request by any Hewlett-Packard Sales and Service office listed at the back of this manual.

1-14. EQUIPMENT SUPPLIED

1-15. Equipment supplied with the Model 5221B and 5321B is listed in Table 1-1.

1-16. ACCESSORIES AVAILABLE

1-17. Accessories available for the Model 5221B and 5321B are listed in Table 1-2.

Table 1-1. Equipment Supplied

Description	HP Part No.
Detachable power cord: 7-1/2 feet (228 cm) long. NEMA plug.	8120-0078
Cable: 4 feet (122 cm) long. Male BNC connectors.	10503A

Table 1-2. Accessories Available

Description	HP Part No.
Rack mount adapter frame (5221B)	5060-0797
Rack mount adapter frame (5321B)	5060-0808
Combining case (used for both)	1052A
Recorder interconnecting cable	10513A
Digital Recorder	5050A

Table 1-3. Specifications

FREQUENCY MEASUREMENT

Range: 5 Hz to 10 MHz.

Input: Maximum sensitivity 100 mV rms.

Impedance: 1 Megohm shunted by 30 pF.

Gate Times: .01, .1, 1, 10 seconds.

Accuracy: ±1 count ±time base accuracy.

Maximum Displayed Frequency: 999.99 kHz (9.99999 MHz Option 01).

TIME INTERVAL MEASUREMENT

Range: 5 μs to .1 s (5 μs to 1 s Option 01).

Input: With GATE SELECTOR set to OPEN, grounding EXT GATE connector closes gate.

Frequency Counted: 1 MHz.

Accuracy: ±1 count ± oscillator accuracy.

Display: Time interval in μs.

RATIO

Range and Sensitivity:
f_a: 5 Hz to 10 MHz, 0.1 V rms into 1 megohm.
f_b: 1 kHz to 1 MHz, 1 V rms into 1000 ohms.

Accuracy: ±1 count of f_a ± trigger error of f_b.
Note: f_b is applied to EXT TIME connector on rear panel. f_a is applied to INPUT connector on front panel.

Display: Multiplier times f_a/f_b. Multiplier can be 10^4, 10^5, 10^6, 10^7.

TIME BASE

Frequency: 1 MHz.

Stability:
Aging Rate: < 1 part in 10^6/month.
Temperature: ±3 parts in 10^5 (0° to 50°C).
±5 parts in 10^6 (10° to 40°C).
Line Voltage: < 1 part in 10^6 for ±10% change in line voltage.

OUTPUT

Frequency: 1 MHz.

Level: 3 V p-p open circuit.

Impedance: 100 ohms.

EXTERNAL INPUT

Sensitivity: 1 V rms sine wave into 1000 ohms (10 V rms maximum).

Range: 1 kHz to 1 MHz.

GENERAL

Display: 5 digits (6 digits Option 01).

Sample Rate: 50 ms to 5 sec.

Reset: Automatic or manual.

SIGNAL INPUT

Sensitivity: 0.1 V rms sine wave from 5 Hz to 10 MHz.

Impedance: 1 megohm shunted by 30 pF.

Attenuation: Stepped attenuator on front panel (0.1, 1, 10 V sensitivity).

Trigger Level Adjustment: Internal adjustment selects either positive or negative pulse operation; 50 ns minimum pulse width.

Overload: Input level should not exceed 100 times the attenuator setting to maintain rated input impedance.

Damage Level: 15/300/300 V rms at attenuator settings of 0.1/1/10 V.

SELF CHECK: Counts 1 MHz for selected gate time.

DIGITAL OUTPUT

Code: 8-4-2-1, "1" level positive. "0" level: 0 V open circuit, 5.1K source impedance.
"1" level: +5 V open circuit, 7.6K source impedance.

Reference Level: Ground and +5 V.

Print Command: Step from +5 V to 0 V, dc coupled; impedance 1 K ohm at +5 V.

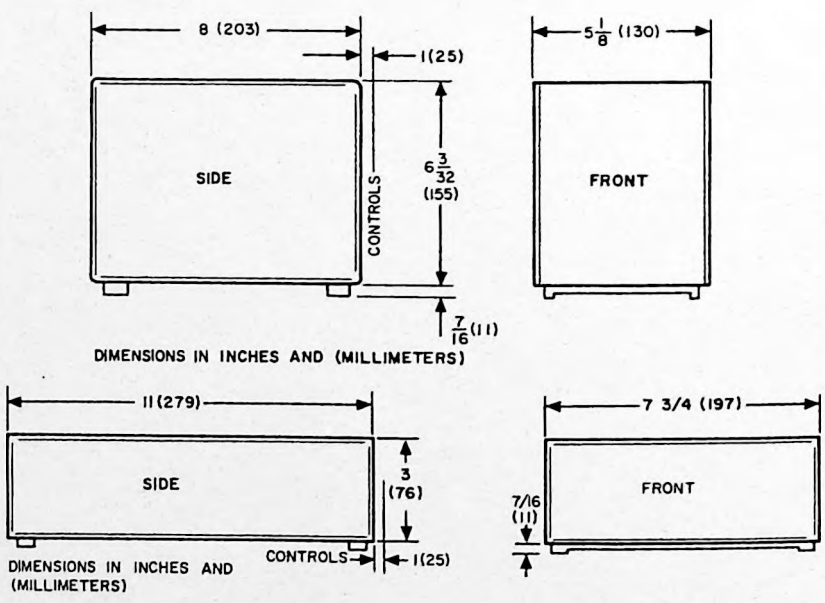
Hold-off Requirements: > +2 V dc inhibits opening of main gate; 56K ohm impedance.

OPERATING TEMPERATURE: 0°C to 50°C.

POWER REQUIREMENTS: 115 or 230 V ±10%, 50 to 400 Hz, 17 W maximum.

WEIGHT: Net, 5-1/2 lb (2,5 kg).
Shipping, 8 lb (3,6 kg).

DIMENSIONS:



OPTIONS: Option 01, 6 digit display.

ACCESSORIES FURNISHED: Detachable power cord and BNC to BNC cable.

SECTION II

INSTALLATION

2-1. UNPACKING AND INSPECTION

2-2. If the shipping carton is damaged, ask that the carrier's agent be present when the instrument is unpacked. Inspect the instrument for damage (dents, scratches, broken knobs, etc). If the instrument is damaged or fails to meet specifications, (performance check, Paragraph 5-9), notify the carrier and the nearest Hewlett-Packard Sales and Service office immediately (offices are listed at the back of this manual). Retain the shipping carton and the padding material for the carrier's inspection. The Sales and Service office will arrange for the repair or replacement of the instrument without waiting for the claim against the carrier to be settled.

2-3. STORAGE AND SHIPMENT

2-4. To protect valuable electronic equipment during storage or shipment always use the best packing methods available. A Hewlett-Packard Sales and Service office can provide packing material such as that used for original factory packaging. Contract packaging companies in many cities can provide dependable custom packaging on short notice. Here are the two recommended packaging methods.

2-5. RUBBERIZED HAIR. Cover painted surfaces of the instrument with protective wrapping paper. Pack instrument securely in strong corrugated container (350 lb/sq. in. bursting test) with 2-inch rubberized hair pads placed along all surfaces of the instrument. Insert fillers between pads and container to ensure a firm fit.

2-6. EXCELSIOR. Cover painted surfaces of the instrument with protective wrapping paper. Pack instrument in strong corrugated container (350 lb/sq. in. bursting test) with a layer of excelsior about 6 inches thick packed firmly against all surfaces of the instrument.

2-7. ENVIRONMENT. Condition during storage and shipment should be limited as follows:

a. Maximum temperature: +167°F (+75°C).

b. Minimum temperature: -40°F (-40°C).

2-8. RACK INSTALLATION

2-9. When the instrument is to be rack mounted, a combining case or adapter frame is required. These are available through Hewlett-Packard Sales and Service offices.

2-10. FILLER PANELS

2-11. When only a portion of a combining case or adapter frame is used, blank filler panels are available to enclose the unused portion. Table 2-1 outlines filler panels available.

Table 2-1. Filler Panels Available

Dimensions	HP Part No.
6-3/32" high, 2-31/64" wide	5060-0795
6-3/32" high, 5-1/8" wide	5060-0793
6-3/32" high, 7-25/32" wide	5060-0794
3-1/32" high, 7-25/32" wide	5060-0097

2-12. MODEL 5221B

2-13. COMBINING CASE. The combining case (HP 1052A) Figure 2-1 can be used as a bench model or it can be rack mounted. A rack mounting kit (HP Part No. 5060-0777) is supplied with the combining case.

2-14. ADAPTER FRAME. The adapter frame (HP Part No. 5060-0797) in Figure 2-1 is a rack frame that can only be rack mounted. Install instruments in the adapter frame as follows:

a. Place adapter frame on edge of bench as shown in step 1 of Figure 2-1.

b. Stack units in frame as shown in step 2. Place spacer clamps between units (step 3).

c. Place two end spacer clamps (step 4) and push units into frame.

d. Insert screws on either side of frame (step 5) and tighten until units are tight in frame. The complete assembly is now ready for rack mounting.

2-15. MODEL 5321B

2-16. COMBINING CASE. The combining case (HP Part No. 1052A) is a unit which accepts four units of 5321B size. The combining case can be used as a bench model or it can be rack mounted. A rack mounting kit (HP Part No. 5060-0777) is supplied with the combining case.

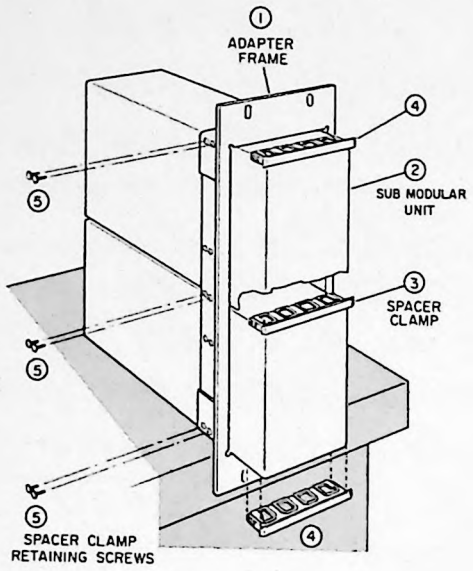
2-17. ADAPTER FRAME. The adapter frame (HP Part No. 5060-0808) similar to Figure 2-1 is a rack frame that accepts two units of 5321B size. It can only be rack mounted. Install the instrument in the adapter frame as follows:

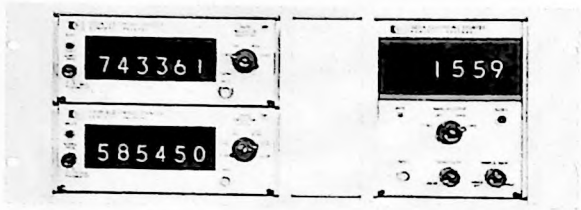
a. Place adapter frame on edge of bench as shown in step 1 of Figure 2-1.

b. Stack units in frame as shown in step 2. Place spacer clamps between units (step 3).

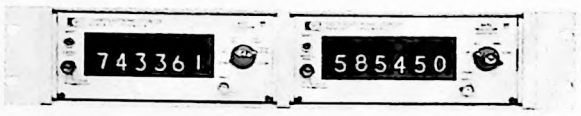
Figure 2-1. Adapter Frame and Combining Case

RACK ADAPTER FRAME

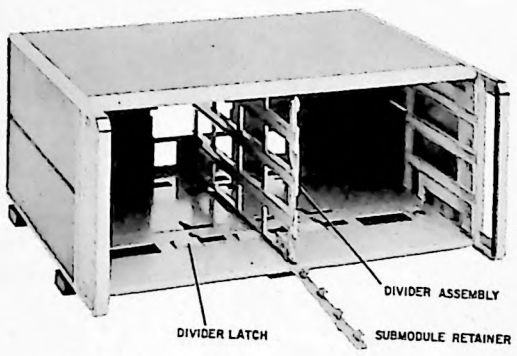


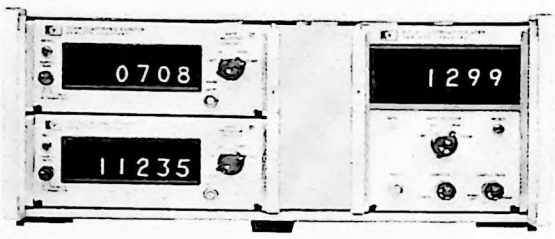


ALTERNATE COMBINATIONS



COMBINING CASE





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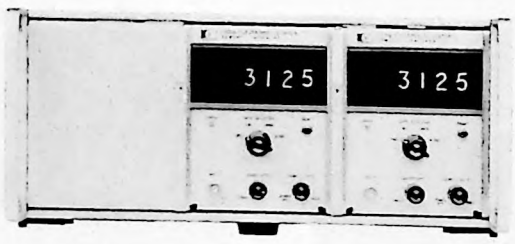
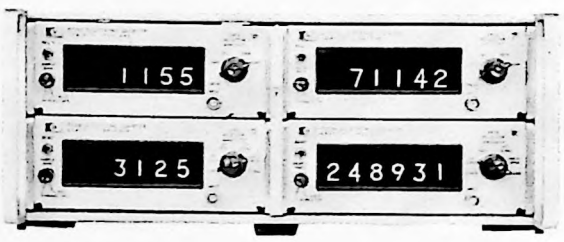
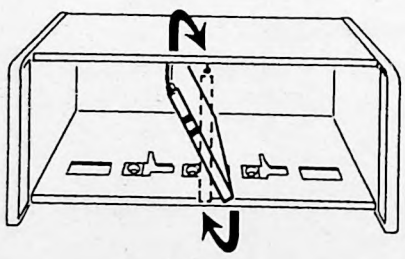


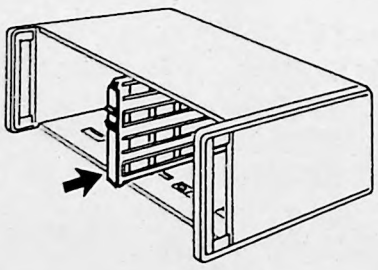


STEP (1)
SLIDE TOP PART TO LIMIT

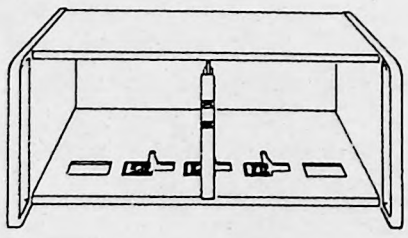
STEP (2)
SLIDE BOTTOM PART TO LIMIT



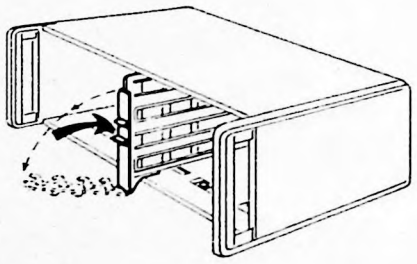
STEP (3)
PUSH IN TO LIMIT



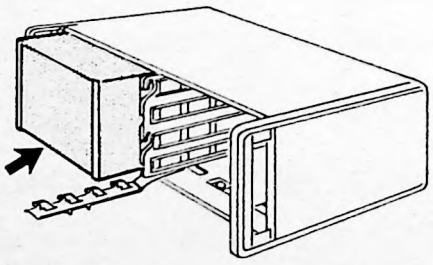
STEP (4)
SLIDE OVER TO LIMIT



STEP (5)
PUSH DOWN TO RELEASE

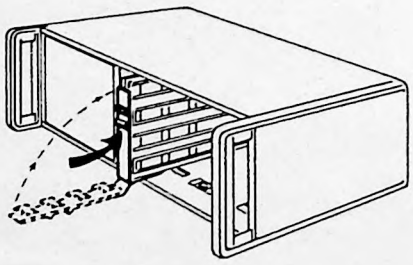


STEP (6)
PLACE INSTRUMENT INTO CASE



STEP (7)
SET RETAINER BACK INTO PLACE

STEP (8)
PUSH UP TO LOCK



ONE HALF MODULE SHOWN FOR TYPICAL INSTALLATION

c. Place two end spacer clamps (step 4) and push units into frame.

d. Insert screws on either side of frame (step 5) and tighten until units are tight in frame. The complete assembly is now ready for rack mounting.

2-18. OPERATION FROM 115 OR 230 VOLTS

2-19. GENERAL. The instrument can be operated from either 115 or 230 Vac (±10%, 50 to 400 Hz) power lines. A slide switch on the rear panel selects operation from either voltage. Insert a narrow blade screwdriver in the switch slot and slide the switch to expose "115" marking for 115 volt operation or "230" marking for 230 volt operation. The ac line fuse is 0.25 ampere for 115 volt and 0.15 ampere for 230 volt operation.

2-20. POWER CONNECTION. The instrument is supplied with a detachable 3-wire power cable. Install as follows:

a. Connect flat plug (3-conductor female connector) to the ac line jack at the rear of the instrument.

b. Connect plug (2-blade male with round grounding pin) to 3-wire grounded ac outlet. Exposed portions of the instrument are grounded through the round pin on the plug for safety. When only a 2-blade outlet is available, use HP adapter 1251-0048 and connect short wire from side of adapter to ground.

SECTION III

OPERATION

3-1. INTRODUCTION

3-2. The Counters have a maximum counting rate of 10 MHz and can measure time interval, the ratio of two frequencies, and total events. The GATE SELECTOR switch selects both measurement function and time base. The SAMPLE RATE control selects the sampling rate and the SENSITIVITY switch controls the instrument sensitivity.

3-3. INTERPETING DISPLAY

3-4. Display is in events per gate time. Decimal point and units are not displayed. With the GATE SELECTOR switch in the OPEN/CLOSE mode the display is read directly as total events.

3-5. ACCURACY

3-6. The basic Counter accuracy is determined by two factors. One factor is the stability of the 1 MHz crystal standard in the time base, which has an aging rate of 1 part per million (.0001%) per month. A second factor is the inherent error of ±1 count present in all digital counters of this type. Therefore the accuracy is ±1 count ±time base accuracy.

3-7. DIGITAL RECORDER OUTPUT

3-8. To supply counter display information to the HP Model 5050A Printer, use digital recorder interconnecting cable HP Part No. 10513A. The DIGITAL RECORDER jack will mate with the 36-pin printed circuit connector A4J1 on the rear panel. Signals available and external signals required are listed in Table 3-1. BCD output code is +8421, "1" state positive.

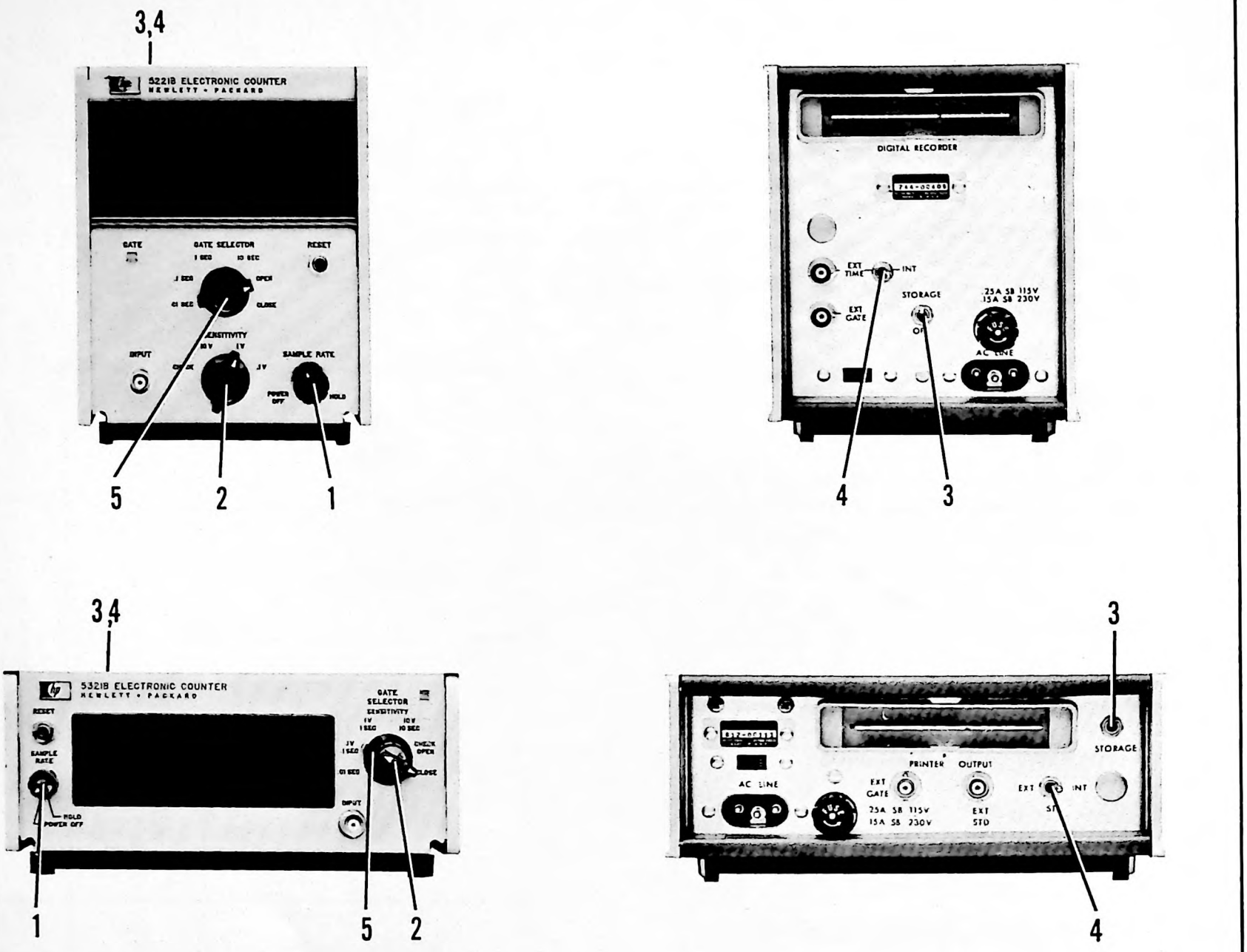
3-9. OPERATION

3-10. Figures 3-1 through 3-5 illustrate operating procedures for various types of measurements.

Table 3-1. Digital Recorder Jack Pin Connections

Function		A4J1 Pin No.
Display	Weight	
(Right End)	8	18
	4	15
10^0	2	16
Units	1	17
	8	5
	4	8
10^1	2	7
Tens	1	6
	8	E
	4	J
10^2	2	H
Hundreds	1	F
	8	P
	4	M
10^3	2	N
Thousands	1	R
	8	K
	4	10
10^4	2	9
Ten Thousands	1	L
	8	12
	4	14
10^5 (Option 01)	2	13
Hundred Thousands	1	11
Print Command output; +5 V to 0 V step, dc coupled		D
Inhibit signal; must be greater than 2 V		B
+5 V positive reference indicates "1" level for BCD output		3, C
Ground		1, A

Figure 3-1. Self Check



1. Set SAMPLE RATE slightly clockwise out of POWER OFF.

2. Set SENSITIVITY to CHECK.

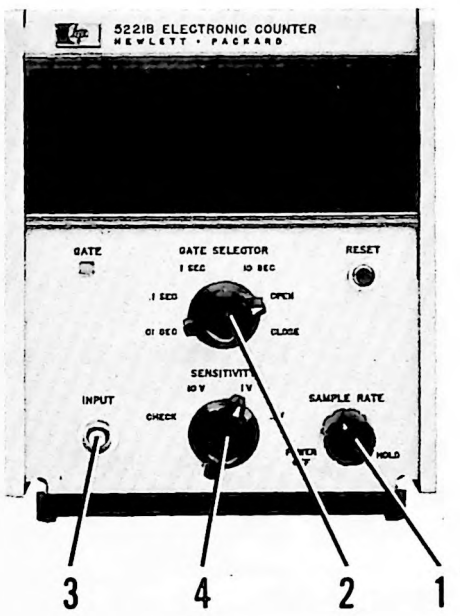
3. Set STORAGE on rear panel to STORAGE.

4. Set EXT TIME on rear panel to INT.

5. Sweep GATE SELECTOR from .01 to 10 SEC and obtain readings shown in table below.

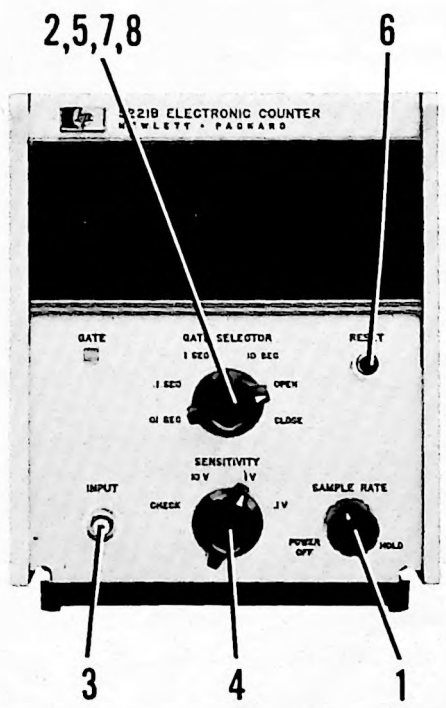
Gate Time	Display	Option 01
.01 SEC	10000	10000
.1 SEC	00000	100000
1 SEC	00000	000000
10 SEC	00000	000000

Figure 3-2. Frequency Measurements



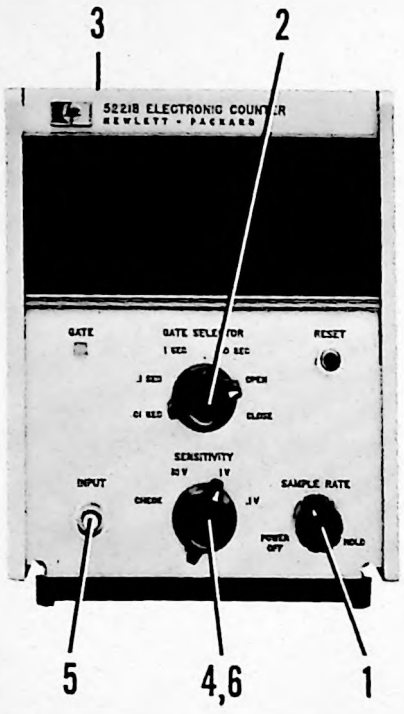
1. Set SAMPLE RATE slightly clockwise out of POWER OFF.
2. Set GATE SELECTOR to 1 SEC. NOTE: Other gate times may be used.
3. Connect signal to be counted to Counter INPUT.
4. Set SENSITIVITY to 10V; if there is no count or if count is erratic, progressively set SENSITIVITY to lower ranges until a consistent count is obtained.
5. Read INPUT frequency on Counter display.

Figure 3-3. Totalizing Operation



1. Set SAMPLE RATE slightly clockwise out of POWER OFF.
2. Set GATE SELECTOR to OPEN.
3. Connect signal to be counted to Counter INPUT.
4. Set SENSITIVITY to 10V; if there is no count or if count is erratic, progressively set SENSITIVITY to lower ranges until a consistent count is obtained.
5. Set GATE SELECTOR to CLOSE.
6. Press RESET.
7. To start count set GATE SELECTOR to OPEN.
8. To stop count set GATE SELECTOR to CLOSE.
9. Read accumulated count from display.

Figure 3-4. Ratio Measurements



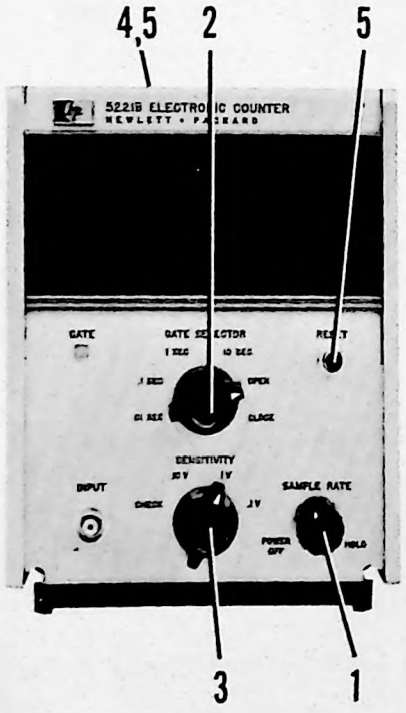
Proceed as follows to measure the ratio between two frequencies (f_a/f_b):

f_a may be between 5 Hz and 10 MHz.

f_b may be between 1 kHz and 1 MHz.

1. Set SAMPLE RATE slightly clockwise out of POWER OFF.
2. Set GATE SELECTOR to .01 SEC (10^4 multiplier). NOTE: Other settings of the GATE SELECTOR may be used to give multipliers up to 10^7.
3. Connect f_b to EXT TIME connector on rear panel and set EXT TIME switch to EXT.
4. Set SENSITIVITY to 10V.
5. Connect f_a to INPUT connector on front panel.
6. Turn SENSITIVITY clockwise until a stable count is displayed.
7. Divide display by multiplier to obtain f_a/f_b.

Figure 3-5. Time Interval Measurements



1. Set SAMPLE RATE slightly clockwise out of POWER OFF.
2. Set GATE SELECTOR to OPEN.
3. Set SENSITIVITY to CHECK.
4. Connect start-stop signal to EXT GATE BNC on rear panel. NOTE: Start = open circuit, stop = ground. These states should be provided by an NPN transistor switch or contact closure.
5. Clear instrument for measurement by grounding EXT GATE BNC and pressing RESET.
6. To start measurement, cut off transistor (open contact); to stop measurement, saturate transistor (close contact).
7. Read time interval (in μs) from display.

SECTION IV
THEORY OF OPERATION

4-1. INTRODUCTION

4-2. This section describes how the Counters operate. A discussion of logic fundamentals is given to help understand how integrated circuits work. Each assembly is discussed in order of its assembly designation. Schematic diagrams are included in Section VIII, Circuit Diagrams.

4-3. GENERAL DESCRIPTION

4-4. Frequency range is from 5 Hz to 10 MHz with a maximum sensitivity of 100 millivolts rms. The Counters include four printed circuit assemblies; 1) Input amplifier A2 amplifies the attenuated input signal, from A1, and triggers the main gate. 2) Oscillator/Time base A3 contains the following circuits:

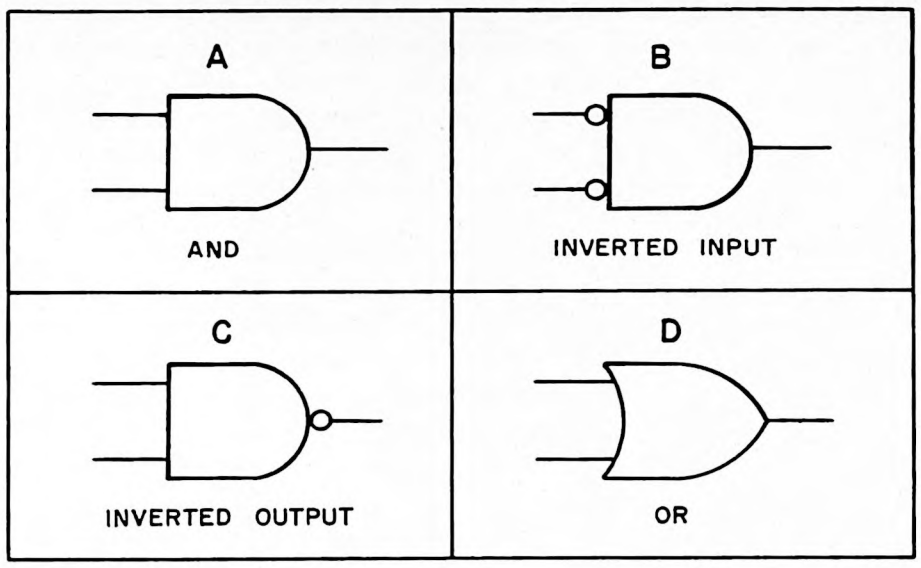
a. 1 MHz oscillator
b. Time base decade dividers
c. Reset and transfer osmv
d. Sample rate MV and main gate flip-flop

3) Counter board A4 includes the main gate and driver for the decade counters, and the buffer storage and decoder drivers for the digital display tubes. 4) Power supply A5.

4-5. GATING AND LOGIC

4-6. The counters use many integrated circuits. Therefore it is necessary to understand basic logic symbols and their application in gating. In the circuit diagrams, AND gate and OR gate symbols are used. The following paragraphs and illustrations introduce logic symbols and their applications.

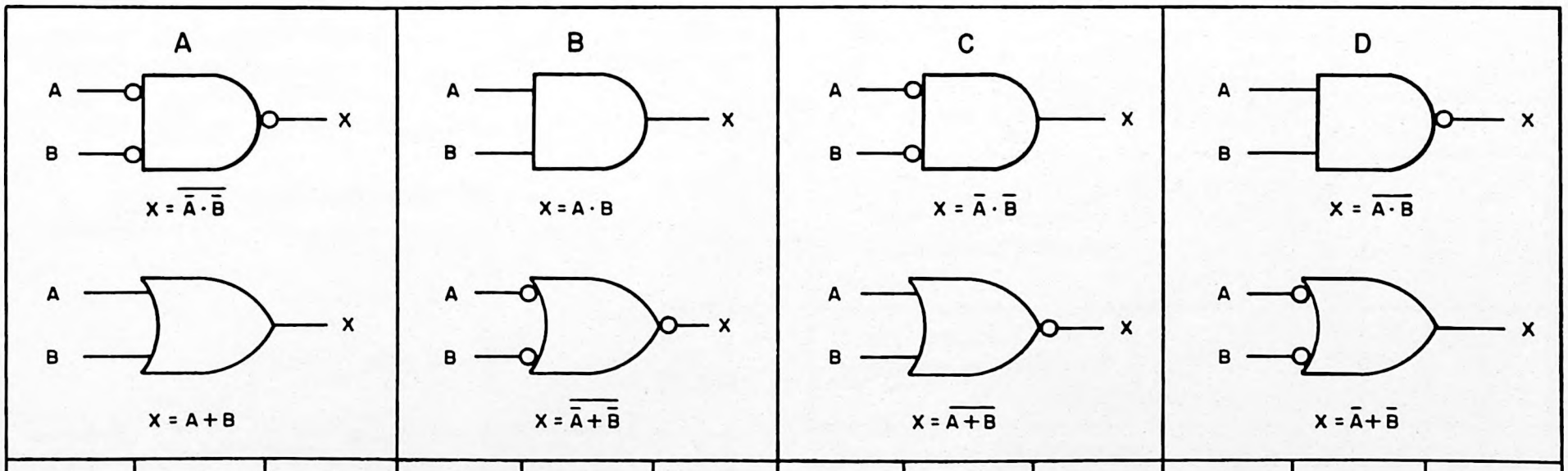
Figure 4-1. Gate Symbols



4-7. LOGIC SYMBOLS

4-8. The symbol shown in Figure 4-1A is for the basic AND gate function. AND gate output is high if all inputs are high. The AND gate can have two or more inputs. The symbol in Figure 4-1D is for the basic OR gate. The OR gate output is high when one or more of its inputs is high. The OR gate can have two or more inputs. A small circle at the input line of a logic symbol indicates a low (L) level activates the function. The symbol in Figure 4-1B shows a low input on all lines causes a high (H) level output. A small circle at the output line of a logic symbol indicates a low (L) level when activated, as shown in Figure 4-1C. Thus a small circle indicates inversion. This applies to both types of gates. Figure 4-2 lists examples and

Figure 4-2. Logic Comparison Diagrams



A	B	X	A	B	X	A	B	X	A	B	X
H	H	H	H	H	H	H	H	L	H	H	L
H	L	H	H	L	L	H	L	L	H	L	H
L	H	H	L	H	L	L	H	L	L	H	H
L	L	L	L	L	L	L	L	H	L	L	H

truth tables for logic actions. When the output of the OR gate is inverted, it is referred to as a NOR gate. Similarly, an inverted AND gate output is a NAND gate.

4-9. In a binary system there are only two states, referred to as H or L. H is the relatively more positive level and L is the relatively less positive level. Positive logic means that the voltage level assigned to the one state is more positive than that assigned to the zero state. Negative logic has the one state less positive than the zero state. Thus, positive logic (logical one) or negative logic (logical zero) must be clearly specified. An H state could be a logical one or a logical zero. However, H must always represent the more positive level. In this manual positive logic is used with the H state (logical one) more positive than the L state (logical zero). A circle at the symbol input shows signal polarity required to activate the function. Figure 4-2 shows four types of symbols that have the same truth tables and can be used interchangeably. The same output function is performed by what appears to be two different logic symbols.

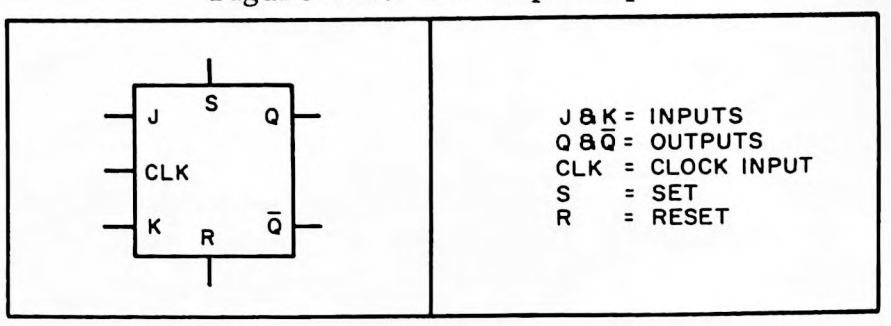
4-10. JK MASTER-SLAVE FLIP-FLOP

4-11. The JK master-slave f-f is basically a bistable MV. A unique feature is that with a simultaneous high input to J and K, before the clock pulse, Q and $\overline{Q}$ will change states after the clock pulse. Refer to Figure 4-3 and Table 4-1. The JK master-slave flip-flop triggers on the trailing edge of the clock pulse. The set (S) and reset (R) inputs operate as follows; if a low is applied to the set input, $\overline{Q}$ will go low. If a low is applied to the reset input, Q will go low. In the JK master-slave f-f, either set or reset can override all other inputs at any time.

Table 4-1. Truth Table

t_n		$t_n + 1$		t_n = Before clock pulse $t_n + 1$ = After clock pulse
J	K	Q	$\overline{Q}$	
L	L	Q_n	$\overline{Q}_n$	If J = L and K = L, then Q and $\overline{Q}$ will not change from what they were before the clock pulse.
H	L	H	L	If J = H and K = L, then Q will be high and $\overline{Q}$ will be low after the clock pulse.
L	H	L	H	If J = L and K = H, then Q will be low and $\overline{Q}$ will be high after a clock pulse.
H	H	$\overline{Q}_n$	Q_n	If J = H and K = H before the clock pulse, then after the clock pulse Q and $\overline{Q}$ will change states.

Figure 4-3. JK Flip-Flop



4-12. ONE-SHOT MULTIVIBRATOR

4-13. The reset and transfer one-shot MV's use two NAND gates as shown in Figure 4-4. With no input, pins 1 and 2 of gate A are held high (about 2.5 V) by R1, 2, 3, and 4. Pin 3 of gate A is low. Pin 6 of gate B is high.

4-14. When a negative pulse is applied to the input, pin 1 of gate A goes low for a time determined by C1, R1, and R2. At this time, pin 3 goes high and produces a low output at pin 6 of gate B. This drives pin 2 of gate A low through C2. C2 now charges through R3 and R4. When C2 has charged sufficiently to allow pin 2 of gate A to go high, pin 3 goes low and permits pin 6 of gate B to return to a high. Thus the output at pin 6 is a negative pulse.

4-15. INPUT ATTENUATOR A1

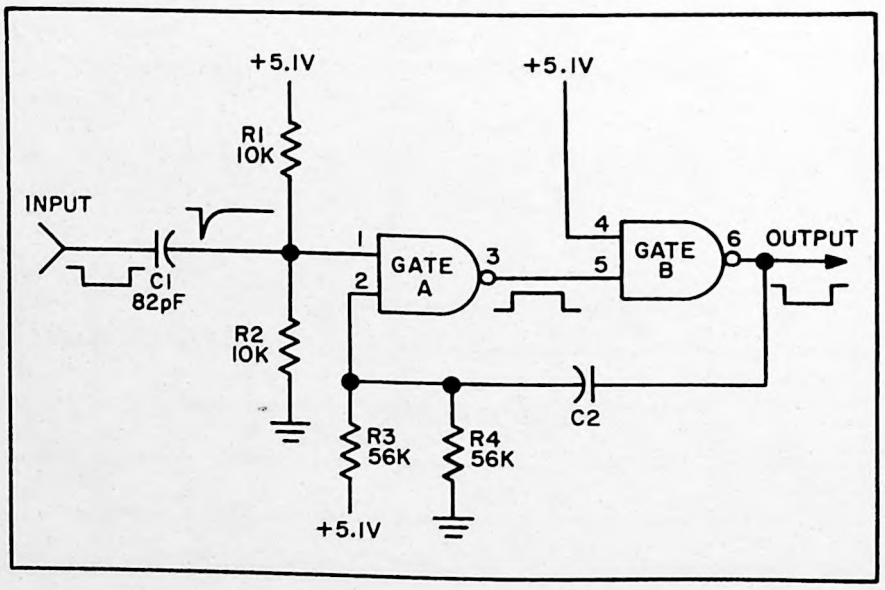
Schematic Diagrams Figures 8-3 and 8-4

4-16. Input attenuator A1 consists of SENSITIVITY switch S2 and associated components mounted on the switch assembly. In CHECK, 1 MHz from A3(C) is applied to input amplifier A2. In the 10 V and 1 V positions, resistive dividers with capacitive compensation are switched in to attenuate the input signal. The .1 V position allows the input signal to be applied directly to input amplifier A2.

NOTE

In the 5321B the SENSITIVITY and GATE SELECTOR switches are mounted together in one assembly (ATTENUATOR/GATE SELECTOR switch assembly, 5321B only).

Figure 4-4. One-Shot Multivibrator



4-17. INPUT AMPLIFIER A2

Schematic Diagrams Figures 8-3 and 8-4

4-18. Input amplifier A2 consists of: 1) an FET source follower, 2) amplifier, 3) Schmitt trigger, 4) output amplifier, and 5) a bias amplifier. A2R20 adjusts the trigger level for positive or negative pulses.

4-19. OSCILLATOR/TIME BASE A3

Schematic Diagram Figure 8-5

4-20. TIME BASE. With the EXT TIME switch S4 set to INT, 1 MHz from Q2 is applied to Schmitt trigger, IC1d and IC1b. The output at IC1b(6) is applied to IC1c(12) to give a 1 MHz output at EXT TIME BNC connector J4 on the rear panel. The signal at IC1b(6) is also applied to IC1a(9) to give a self check signal at pin C. Decade dividers, IC2, 3, and 5 divide the 1 MHz signal from IC1b(6) down to 1 kHz. This signal is applied to NAND gate IC7a. When pins 10 and 11 of this gate are high (see Figure 4-5), 1 kHz will be present at the output (pin 8). Decade dividers IC4, 6, 8, and 9 divide the 1 kHz signal from IC7a(8) by 10, 100, 1000, or 10,000 depending on the setting of GATE SELECTOR switch S1. The output lines of IC4, 6, 8, and 9 are tied together and provide the clock input for main gate f-f IC11b(1). If, for example, the GATE SELECTOR switch is set to .1 SEC pin 7 of IC6 will be grounded. This will cause the output of IC6(6) to appear at the clock input of the main gate f-f. The output of IC6(6) will be 10 Hz, or .1 second.

4-21. MAIN GATE F-F. With the GATE SELECTOR switch set to OPEN, CR9 and CR10 are grounded. This disables transfer multivibrator IC10a and IC10c and sample rate multivibrator IC11a. NAND gate IC10b now has a low output at pin 6. This signal is applied to main gate f-f IC11b(2) resulting in a low output at pin 14. The output at pin 14 is applied to Q5 base (print command buffer) and to Q8 base (gate light amplifier). This signal is also applied to main gate transistor A4Q2 to open the main gate. With the GATE SELECTOR set to CLOSE, the transfer and sample rate multivibrators are disabled by grounding CR11 and CR12. At this time there is a low input applied to IC10b(4) to reverse main gate f-f and close the main gate. With the GATE SELECTOR switch set to OPEN, the gate may be closed by grounding the EXT GATE terminal on the rear panel. This produces a low input to IC10b(4) through CR19 to close the main gate.

4-22. RESET. Reset is done by grounding the inputs of the transfer and reset multivibrators through CR6 and CR4, respectively. This allows the reset MV to trigger and give a negative pulse to NAND gate IC7a(11) and reset of main gate f-f IC11b(13). At this time IC5 is reset to zero while IC4, 6, 8, and 9 are reset to 9. A pulse is applied to reset amplifier Q3 and resets the decade counters on A4 to zero.

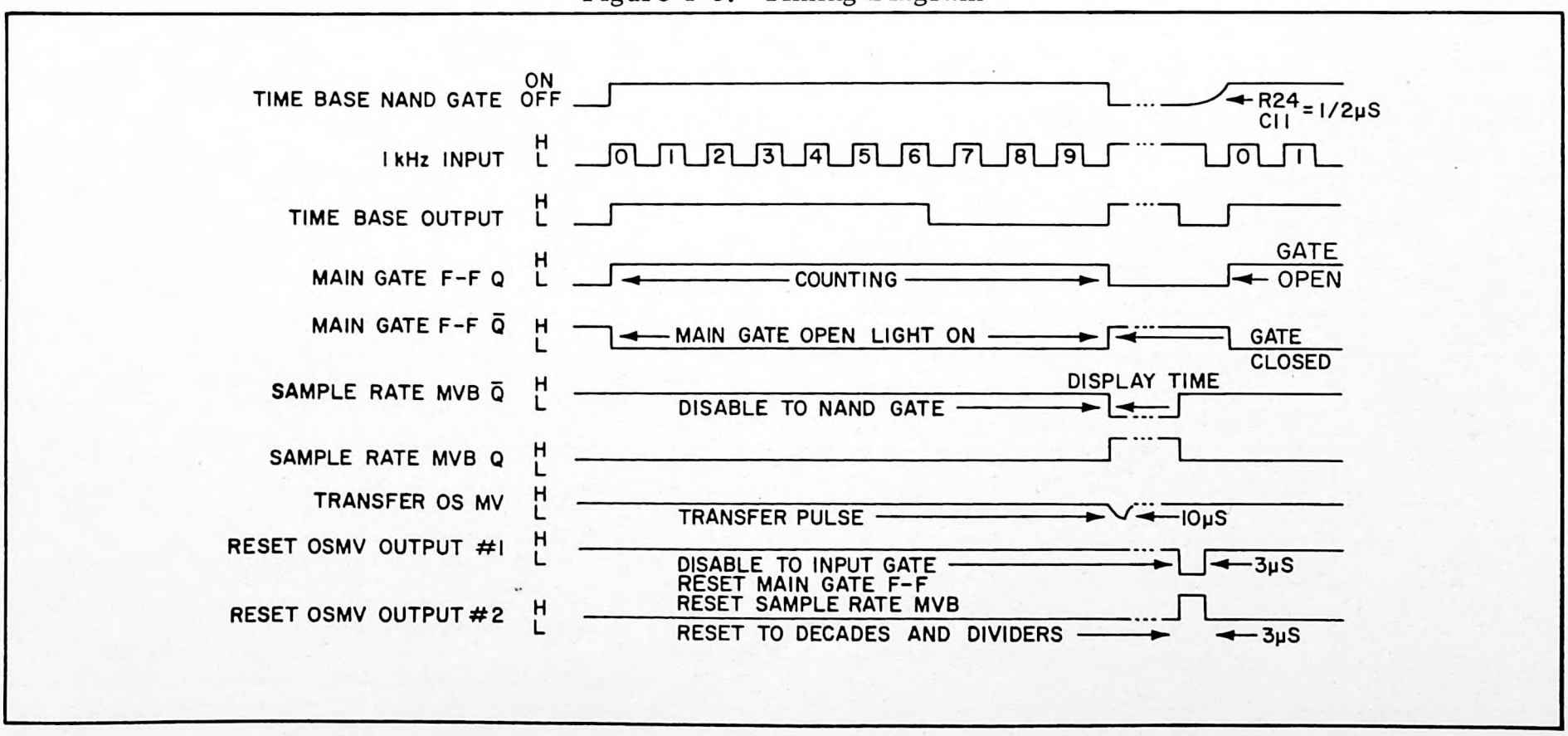
4-23. STORAGE. In the storage mode, pin 5 of the buffer storage units on A4 is held high by IC10c(11). This prevents information in the decade counters from reaching the buffer storage units. When a negative pulse occurs (after the main gate has closed) information in the decade counters is transferred to the buffer storage units and the new count is displayed. When the STORAGE switch is OFF, the transfer MV is disabled by grounding pin 9 of IC10a. This holds the output of IC10c(11) low and allows a continuous transfer of information from the decade counters to the buffer storage units and decoder drivers on A4.

4-24. COUNTER BOARD A4

Schematic Diagram Figure 8-6

4-25. MAIN GATE. Transistors Q1 and Q2 are the main gate. When Q2 base is low, the counted signal at Q1 base is allowed to pass on to the driver (Q3 and Q4) and decade counters.

Figure 4-5. Timing Diagram



4-26. BLANKING. Blanking occurs when the STORAGE switch is on and pin 10 of decade counters IC6, 9, 12, and 15 are grounded. This feature permits blanking of unwanted zeros in the display (zeros left of the most significant digit).

4-27. DECADE COUNTERS. Decade counter IC3 is a high speed, non-blanking decade. Input is on pin 5. It gives a four line 8421 coded signal to buffer unit IC2. Decade counters IC6, 9, 12, and 15 are low frequency blanking decades.

4-28. BUFFER STORAGE UNITS. These devices have four inputs and eight outputs. Four of the output lines carry coded information to the decoder drivers. The other four output lines are the BCD output for the digital recorder connector on the rear panel. When pin 5 of a buffer storage unit is low it assumes the state of the decade counter feeding it. The information is then transferred to the decoder drivers. Pin 5 will be low when there is a transfer pulse or when the STORAGE switch is OFF.

4-29. DECODER DRIVERS. The decoder drivers are 8421 four-line to 10-line decoders with four inputs and ten outputs. A low from the decoder driver to a number in the digital display tube will light that number.

4-30. POWER SUPPLY A5

Schematic Diagram Figure 8-7

4-31. GENERAL. Power supply assembly A5 gives three regulated voltages: +155, +5.1, and -12 V. These are the operating voltages for the instrument.

NOTE

In the following discussion, complete reference designations are used to prevent confusion between parts located on the chassis and parts located on printed circuit board A5.

4-32. PRIMARY POWER. Either 115 Vac or 230 Vac is connected through fuse F1 and power switch S2 (part of SAMPLE RATE control R1). Slide switch S6 on the rear panel connects T1 primary windings in parallel for 115 V operation or in series for 230 V operation.

4-33. MINUS 12 V SUPPLY. The regulated -12 volt supply consists of full wave bridge rectifier A1CR5 through A5CR8 whose output is filtered by A5C1, regulated by A5Q1, and further filtered by A5C4. Breakdown diode A5CR15 gives a 12.7 V reference for A5Q1. When the output voltage attempts to change, A5Q1 conducts more or less to oppose this change.

4-34. PLUS 5.1 V SUPPLY. The +5.1 volt supply consists of full wave bridge rectifier A5CR9 through A1CR12 whose output is filtered by A5C2 and regulated by Q1. A5Q4 is the reference amplifier whose gain is adjusted by A5R6. Breakdown diode A1CR17 gives the reference voltage for A5Q4. Thermistor A5RT1 provides temperature compensation for resistive dividers A5R6, A5R7, and A5R8. This helps to maintain the gain of the reference amplifier.

4-35. PLUS 155 V SUPPLY. The +155 volt supply is actually a regulated ac current source whose output is positive with respect to ground. The supply consists of full wave bridge rectifier A5CR1 through A5CR4. Current regulator A5Q2 controls the output level. Breakdown diodes A5CR13, A5CR14, and A5CR16 hold A5Q2 base at a constant level. These diodes also give some temperature compensation to minimize intensity changes in the display tubes. The +155 V output is adjusted by A5R1. The circuit board also has additional components (A5R9, 10, 11, and C6) which give a 90 V output at pin 9. This voltage is not used.

SECTION V
MAINTENANCE

5-1. INTRODUCTION

5-2. This section gives maintenance and service information for the Model 5221B and 5321B Electronic Counters. Included are a table of recommended test equipment, troubleshooting procedures, repair and adjustment procedures, and an in-cabinet performance check which may be used to verify proper operation of the Counter.

5-3. ASSEMBLY DESIGNATIONS

5-4. Table 5-1 lists the designation, name, and part number of the assemblies used in the Counters.

5-5. TEST EQUIPMENT

5-6. Recommended test equipment for troubleshooting and performance checking is listed in Table 5-2. Test instruments other than those listed may be used if their specifications equal the required characteristics.

5-7. ASSEMBLY CONNECTION IDENTIFICATION

5-8. Throughout the manual, connections to printed circuit assemblies are referred to in abbreviated form. For example, connection to A5 pin 6 is A5(6).

Table 5-1. Assemblies

Assy	Name	HP Part No.
A1 A1	Input Attenuator Atten./Gate Selector	05221-6025 (5221B) 05321-60009 (5321B)
A2 A2	Amplifier/Trigger Amplifier/Trigger	05221-6012 (5221B) 05221-6002 (5321B)
A3	Osc./Time Base	05221-6011
A4 A4	Counter Board Counter Board	05221-6013 (5221B) 05221-6026 (Opt. 01) 05321-60001 (5321B) 05321-60010 (Opt. 01)
A5	Power Supply	05221-6010

5-9. IN-CABINET PERFORMANCE CHECK

5-10. GENERAL. The performance check in Table 5-4, and Test Card verify proper operation of all circuits in the Counters and may be used:

Table 5-2. Recommended Test Equipment

Instrument Type	Required Characteristics	HP Part No.
Low Frequency Oscillator	5 Hz to 50 kHz, 1 V rms	200CD (2)
High Frequency Oscillator	50 kHz to 10 MHz, 1 V rms	651B
Pulse Generator	±50 ns, 0.3V, 100 kHz, and single pulses from 5 μs to 100 ms wide.	8003A
Oscilloscope Dual Trace Plug-In Horizontal Plug-In	20 MHz Bandwidth 5 mV/cm	140A 1402A 1420A
Electronic Counter	Plug-in capability	5245L
Time Interval Plug-in	5 μs to .1 sec	5262A
Divider Probe	10:1, 10 pF, dc to 30 MHz	10001A
Divider Probe	50:1, 2.5 pF, dc to 30 MHz	10002A
50-ohm Feedthrough Termination	Male to female BNC	10100A
DC VTVM	0 to ±300 Vdc, ±1%, 200 megohm impedance	412A
AC VTVM	10 Hz to 10 MHz, ±4%, .001 to 300 V rms	400E
AC Transistor Voltmeter	5 Hz to 10 Hz, ±5%, .001 to 300 V rms	403B
BNC "T" Connector		1250-0781
1 MHz Frequency Standard	Stability, ±1 part in 10^7/month	107AR
Digital Recorder Digital Recorder Interconnecting Cable	Must be compatible with Counter	5050A 10513A

a. as a part of an incoming inspection check of instrument specifications,

b. periodically, for instruments used in systems where maximum reliability is important,

c. as a part of a troubleshooting procedure to locate malfunctioning circuits, and

d. after any repairs or adjustments, before returning instrument to regular service.

5-11. VARIABLE LINE VOLTAGE. During the following tests (Table 5-4), the Counter should be connected through a variable voltage source so that line voltage may be varied ±10% from nominal (115 or 230 Vac) to assure proper operation of Counter under these supply conditions.

5-12. INSTRUMENT COVER REMOVAL

5-13. To remove top, bottom, or side covers, remove Phillips-head screws. Side covers must be removed for access to adjustments.

WARNING

115/230V AC AND +155V DC SUPPLY WIRES ARE EXPOSED WHEN EITHER TOP OR BOTTOM INSTRUMENT COVER IS REMOVED. USE EXTREME CAUTION DURING TROUBLESHOOTING, ADJUSTMENT, OR REPAIR. AVOID DAMAGE TO INSTRUMENT BY REMOVING POWER BEFORE REMOVING OR REPLACING COVERS, ASSEMBLIES, OR COMPONENTS.

5-14. ADJUSTMENTS

5-15. Power Supply A5

5-16. To check and adjust power supply voltages, perform the following:

a. Set line voltage to normal value (115 or 230 Vac).

c. Voltmeter should read between +145 and +165 Vdc. If voltage is outside this range, adjust A5R1 (see Figure 5-1 for 5221B or Figure 5-2 for 5321B).

d. Vary line voltage from 103 to 127 Vac (206 to 254 Vac). The +155 Vdc supply should stay between +145 and +165 Vdc. See Table 5-4.

e. Set line voltage to normal (115 or 230 Vac).

f. Connect dc voltmeter to A5(1).

g. Voltmeter should read between +4.95 and +5.25 Vdc. If voltage is outside this range, adjust A3R6 (see Figure 5-1 for 5221B or Figure 5-2 for 5321B).

h. Vary the line voltage from 103 to 127 Vac (206 to 254 Vac). The +5.1 Vdc supply should stay between +4.95 and 5.25 Vdc.

5-17. Amplifier -Trigger Assembly A2

5-18. Paragraph 5-19 is a procedure to test input amplifier trigger assembly A2 for proper operation. If any test is not passed, see Paragraphs 5-20 and 5-21 for trigger adjustment procedure.

5-19. 5 Hz to 10 MHz CHECK.

a. Set SENSITIVITY to .1V.

b. Connect Test Oscillator to Counter INPUT. Set Oscillator output to 5 Hz at 0.1 V rms.

c. Connect Oscilloscope to A2 output. Oscilloscope display should be a rectangular wave, about 50% positive and 50% negative.

d. Vary input frequency from 5 Hz to 10 MHz.

e. Oscilloscope display should remain a jitter-free rectangular wave at any frequency between 5 Hz and 10 MHz.

5-20. ADJUSTMENT FOR SINE WAVE OPERATION.

a. Set SENSITIVITY control clockwise.

b. Connect 100 kHz sine wave at 0.1 V rms to Counter INPUT.

c. Turn A2R20 (trigger level adjust; see Figure 5-1 for 5221B or Figure 5-2 for 5221B) fully clockwise.

d. Turn A2R20 counterclockwise until A2 output, as observed on oscilloscope, is a stable rectangular waveform, 50% positive and 50% negative (50% duty cycle).

5-21. ADJUSTMENT FOR PULSE OPERATION.

Note

Optimum adjustment for pulse operation will differ from optimum sine wave adjustment. Use this adjustment only for pulse operation. Input Schmitt trigger may be adjusted for either positive or negative pulse operation.

a. Connect Pulse Generator to Counter INPUT. Set Pulse Generator for 50 ns, 300 mV pulse of desired polarity. Set repetition rate to 100 kHz.

b. Connect Oscilloscope to A2 output. Adjust A2R20 until a stable pulse is displayed.

Table 5-3. Power Supply Voltage

Test Point	AC Line Voltage			Adjustment	Ripple and Noise
	(206) 103	(230) 115	(254) 127		
A5(6)	+155 ±10	+155 ±10	+155 ±10	A5R1	Not filtered
A5(1)	+5.1 ±.15	+5.1 ±.15	+5.1 ±.15	A5R6	.01V rms max.
A5(5)	-12 ±.5	-12 ±.5	-12 ±.5	None	.003V rms max.

Table 5-4. In-Cabinet Performance Check

FREQUENCY MEASUREMENT

1. RANGE: 5 Hz to 10 MHz

a. Set Counter controls as follows:

SENSITIVITY . . . . . .1 V
SAMPLE RATE . . . slightly clockwise out of POWER OFF
GATE SELECTOR. . . . . 1 sec

b. With BNC "T", connect output of Low Frequency Oscillator to Counter INPUT and Oscilloscope input. The Oscilloscope monitors input signal level. Set Oscillator for 0.1 V rms (0.28 V p-p).

c. Vary Oscillator frequency from 5 Hz to 50 kHz, keeping output at 0.1 V rms (0.28 V p-p). Counter should properly display frequencies in this range. Record on Test Card.

d. Substitute High Frequency Oscillator for Low Frequency Oscillator. Vary Oscillator frequency from 50 kHz to 10 MHz, keeping output at 0.1 V rms (0.28 V p-p). Counter should properly display frequencies in this range. Record results on Test Card.

NOTE: For frequencies above 99.999 kHz (999.999 kHz Option 01) the most significant digit is not displayed.

e. To measure pulses, A2R20 must be adjusted for either positive or negative pulse operation. Refer to Paragraph 5-21 for this adjustment.

NOTE: If A2R20 has been adjusted for pulse operation, sine wave sensitivity will be affected. Steps d and e above will require an input level greater than 0.1V rms.

f. Perform the following check if A2R20 has been adjusted for pulse operation. Connect Pulse Generator to Counter INPUT with normal recommended load. Set Pulse Generator for 50 ns, 300 mV pulse, ± depending on setting of A2R20. Set repetition rate of Pulse Generator to 100 kHz. The Counter should display this frequency.

2. INPUT SENSITIVITY: 0.1 V rms sine wave.

NOTE: Internal control (A2R20) may be adjusted for either positive or negative pulse operation.

Sensitivity is checked by procedure of Item 1, under FREQUENCY MEASUREMENT. Record.

TIME INTERVAL MEASUREMENT

1. RANGE: 5 μs to .1 sec.

a. Set Counter controls as follows:

SENSITIVITY . . . . . CHECK
SAMPLE RATE. . . . . .clockwise out of POWER OFF
GATE SELECTOR . . . . . .OPEN

b. Connect Pulse Generator output to EXT GATE connector on Counter. Use 5245L with 5262A plug-in to monitor Pulse Generator output.

c. Set Pulse Generator for + single pulse operation and set pulse width to 5 μs.

d. Press RESET button on Counter. Press MANUAL button on Pulse Generator and note reading on Counter display. Counter should properly display time interval in μs. Vary pulse width from 5 μs to .1 sec. and observe Counter display. Record.

Table 5-4. In-Cabinet Performance Check (cont'd)

RATIO MEASUREMENT

1. f_a FREQUENCY RANGE: 5 Hz to 10 MHz

   Checked by procedure of Item 1, under Frequency Measurement Record.

2. f_b FREQUENCY RANGE: 1 kHz to 1 MHz.

   a. Set Counter controls as follows:

   SENSITIVITY . . . . . .1 V
   SAMPLE RATE . . . . . clockwise out of POWER OFF
   GATE SELECTOR . . . . . as indicated in table below
   EXT TIME . . . . . EXT
   STORAGE . . . . . ON

   b. Connect Signal Generator No. 1 output (0.1V rms) to Counter INPUT (f_a). Set Generator frequency as shown in table below.

   c. Connect Signal Generator No. 2 output (1 V rms) to Counter EXT TIME jack (f_b). Set Generator frequency as shown in table below.

   d. Make checks shown in table below. Record.

f_a	f_b	GATE (multiplier) SELECTOR	Display
1 kHz	1 kHz	.01 SEC (10^4)	10000
5 kHz	5 kHz	.01 SEC (10^4)	10000
10 kHz	10 kHz	.01 SEC (10^4)	10000
5 kHz	50 kHz	.1 SEC (10^5)	10000
10 kHz	100 kHz	.1 SEC (10^5)	10000
5 kHz	500 kHz	1 SEC (10^6)	10000
10 kHz	1 MHz	1 SEC (10^6)	10000

TIME BASE

1. STABILITY: Aging Rate: ±1 part in 10^6/month
   Temperature: ± 3 parts in 10^5 (+0° to +50°C)
   ± 5 parts in 10^6 (+10° to +40°C)

   Line Voltage: ± 1 part in 10^6 for ±10% line voltage change.

   a. Set Counter controls as follows:

   EXT TIME . . . . . INT
   SAMPLE RATE. . . . . clockwise out of POWER OFF

   b. Connect 1 MHz frequency standard to Oscilloscope trigger input.

   c. Connect Oscilloscope vertical input to Counter EXT TIME jack.

   d. Set Oscilloscope for external triggering and .1 μs/cm sweep.

Table 5-4. In-Cabinet Performance Check (cont'd)

TIME BASE (cont'd)

e. Horizontal drift of Oscilloscope pattern in cm/sec. is difference between standard frequency and Counter time base frequency in parts in 10^6. Record.

f. Record frequency difference. For long term stability, this test should be made daily for one month.

g. Vary line voltage ± 10% and record frequency difference.

h. Vary operating temperature from +10°C to +40°C and record frequency difference.

i. Vary operating temperature from 0°C to +50°C and record frequency difference.

2. OUTPUT: 1 MHz at 3V p-p open circuit, 100 ohms source impedance.

a. Connect Oscilloscope vertical input to Counter EXT TIME jack.

b. Oscilloscope should display a 1 MHz nonsinusoidal wave of 3V p-p. Record.

3. EXTERNAL INPUT: 1 V rms sine wave into 1000 ohms (10 V rms max). Range, 1 kHz to 1 MHz. Checked by procedure of Item 2, under RATIO. Record.

DIGITAL OUTPUT

1. CODE: 8-4-2-1 "1" level positive "0" level: 0V open circuit, 5.1 k ohm source impedance.
"1" level: +5V open circuit, 7.6 k ohm source impedance.

a. Set Counter controls as follows:

SENSITIVITY . . . . . .1 V
SAMPLE RATE . . . . . slightly clockwise out of POWER OFF
GATE SELECTOR . . . . . .01 SEC

b. Connect Counter DIGITAL RECORDER jack to Digital Recorder with HP 10513A cable.

c. Observe flashing rate of Counter GATE light. Turn Printer on and note a decrease in Counter GATE light flashing rate. Record.

d. Set Counter GATE SELECTOR to OPEN.

e. Connect Signal Generator to Counter INPUT (while holding Printer Record switch down) and vary frequency from 10 Hz to 10 MHz. Observe that all digits in each column of the Printer are displayed correctly. Record.

5-22. TROUBLESHOOTING

5-23. General

5-24. Trouble isolation can best be accomplished by first obtaining all possible information from the controls, indicators, and connectors; then logically applying this information to locate the defective circuit or component. Operating procedures in Section III and circuit diagrams in Section VIII can be used to help understand operation. Table 5-1 lists the assemblies in the instrument. Figure 5-1 shows the location of assemblies and chassis-mounted components in the 5221B and Figure 5-2 shows locations in the 5321B. Refer to component location figures, voltages, waveforms, and schematic diagrams in Section VIII. The performance check in Table 5-4 is also useful for locating trouble.

5-25. Module Substitution

5-26. Maintenance procedures may be greatly simplified if troubleshooting is done by replacing a bad assembly with a spare assembly known to be operating correctly. When bad assembly is found, trouble then may be traced to the individual components responsible, or the assembly may be shipped to your Hewlett-Packard Sales and Service office for repair.

5-27. Removal of Main Board Assembly A2

5-28. To remove main board assembly A2:

a. Remove the top and both side covers (see Paragraph 5-13).

b. For 5221A, remove front panel window by sliding it out either way.

c. For 5321A, remove front panel window by pushing top of window down at the same time pulling out. When window is released pull up and out.

d. Reach inside the side castings and gently lift sides of main board. Pull the board forward with the fingers.

e. After board is started, remove connector XA2.

f. Push or pull board out of counter being careful to keep board moving in a straight line.

g. To replace board, reverse the above procedure.

Make sure connector XA2 is reconnected and none of the wires are pinched by the board.

5-29. Troubleshooting Assemblies

5-30. Refer to Section IV, Theory of Operation, for information on the operation of circuits. Consult the component location figures, signal waveforms, and voltages which are included with the assembly schematics in Section VIII.

5-31. Printed Circuit Component Replacement

5-32. Component lead-holes in the counter's circuit boards have plated walls to ensure good electrical contact between conductors on the opposite sides of the board. To prevent damage to this plating and to the replacement component, apply heat sparingly, and work carefully. The following replacement procedure is recommended:

a. Remove defective component.

b. Melt solder in component lead-holes. Use clean dry soldering iron to remove excess solder. Clean holes with toothpick or wooden splinter. Do not use metal tool for cleaning as this may damage through-hole plating.

c. Bend leads of replacement component to the correct shape and insert component leads into component lead-holes. Using heat and solder sparingly, solder leads in place. Heat may be applied to either side of board. A heat sink (longnose pliers, commercial heat-sink tweezers, etc) should be used when replacing transistors and diodes in order to prevent excessive heat from being conducted by the leads from the soldering iron to the component.

d. Through-hole plating breaks are indicated by the separation from the board of the round conductor-pad on either side of the board. To repair breaks, press conductor-pads against board and solder replacement component lead to conductor-pad on both sides of board.

5-33. Replacing Integrated Circuits

5-34. If it becomes necessary to replace an integrated circuit, clip the leads as close to the case as possible. With a soldering iron and long nose pliers, carefully remove the wires from each hole. Clean holes as described in Paragraph 5-32 step b.

5-35. Troubleshooting Aids

5-36. When trouble is suspected, refer to Section III and perform SELF CHECK procedure. If Counter does not pass SELF CHECK, refer to Table 5-5 for a detailed breakdown of Counter operation in various modes. Once the problem is isolated to a particular area, refer to schematic diagrams in Section VIII.

PERFORMANCE CHECK TEST CARD

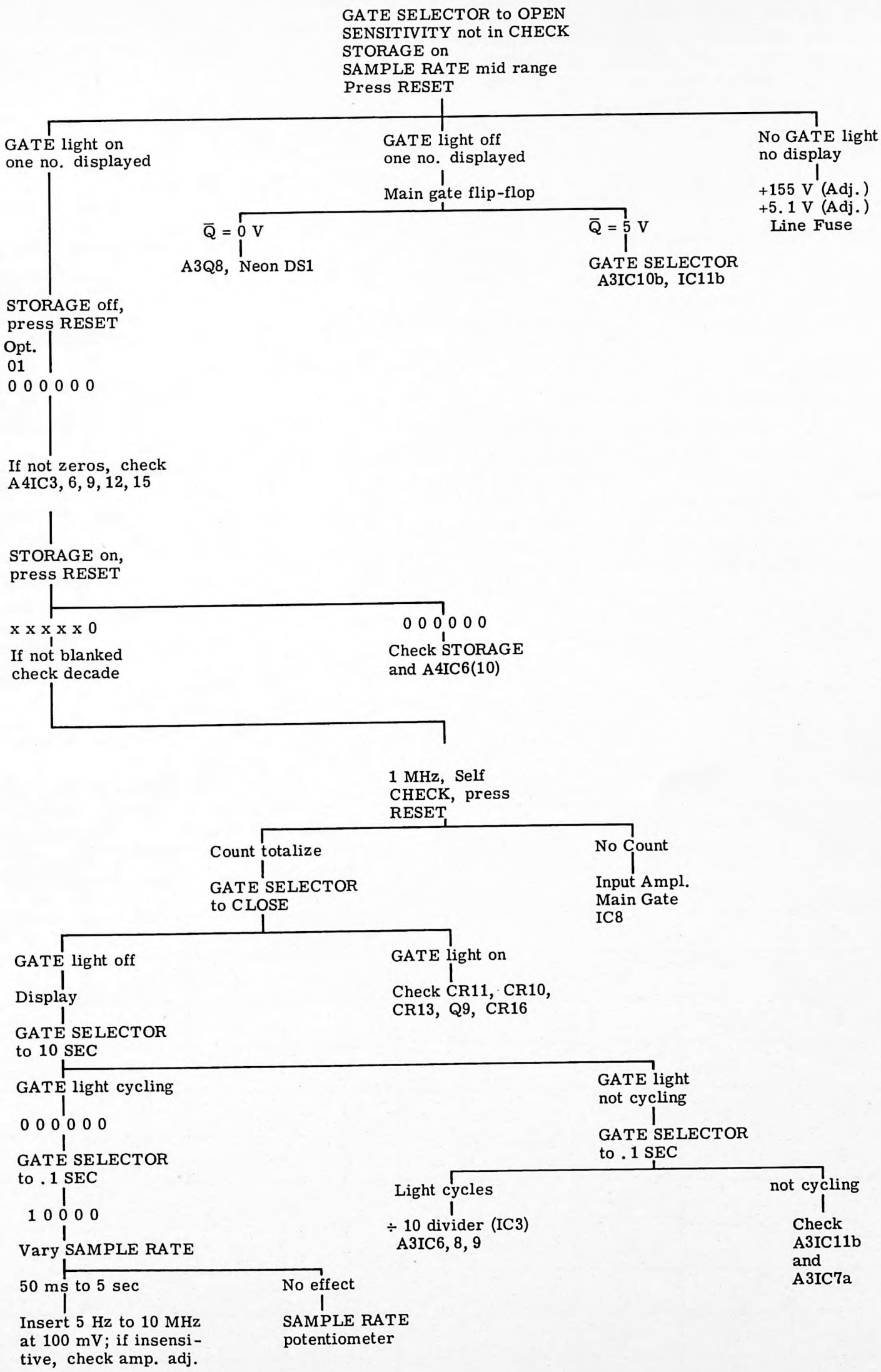
Hewlett-Packard Model 5221A/5321A
Electronic Counter
Serial No. _____ - _____

Tests Performed by _____

Date _____

DESCRIPTION	CHECK	
FREQUENCY MEASUREMENT		
1. Range: 5 Hz to 10 MHz		5 Hz to 10 MHz
2. Input Sensitivity: 0.1V rms sine wave, 5 Hz to 10 MHz		0.1 V rms
TIME INTERVAL MEASUREMENT		
1. Range: 5 μs to .1 sec		5 μs to .1 sec
RATIO MEASUREMENT		
1. f_a Frequency Range: 5 Hz to 10 MHz		5 Hz to 10 MHz
2. f_b Frequency Range: 1 kHz to 1 MHz		1 kHz to 1 MHz
TIME BASE		
1. Stability: Aging Rate: ±1 part in 10^6/month		less than ±1 part in 10^6/mo.
Temperature: ±3 parts in 10^5 (0°C to +50°C)		±3 parts in 10^5
±5 parts in 10^6 (+10°C to +40°C)		± 5 parts in 10^6
Line Voltage: ±1 part in 10^6 for ±10% change		less than ±1 part in 10^6
2. Output: 1 MHz at 3V p-p		1 MHz, 3V p-p
3. External Input: 1 V rms sine wave 1 kHz to 1 MHz		1 V rms, 1 kHz to 1 MHz
DIGITAL OUTPUT		
1. CODE: 8-4-2-1 "1" state = +5V "0" state = 0V		
c. Gate light flashing		decreases when printer is on
e. Printer displays all digits of each column		Printer displays all digits

Table 5-5. Troubleshooting Chart



5-39. Decade Counters

5-40. With the exception of A4IC3 (see Table 5-6) all decade counters receive signal input on pin 9 and supply a divide-by-10 output on pin 8. A4IC3 has its input on pin 5 and divide-by-10 output on pin 1. All decade counters provide -8421 ($\overline{D}\overline{C}\overline{B}A$) BCD output to their associated buffer storage units. Refer to Table 5-7. This output is taken from pins 1, 8, 7, and 6 on A4IC3 and pins 16, 2, 1, and 15 on the remaining decade counters.

5-41. Buffer Storage Units

5-42. The buffer storage units receive -8421 ($\overline{D}\overline{C}\overline{B}A$) BCD code on pins 9, 7, 8, and 10 from the decade counters when there is a negative transfer pulse at pin 5 or when pin 5 is held low (storage off). -8421 ($\overline{D}\overline{C}\overline{B}A$) output is from pins 16, 3, 1, and 14. Refer to Table 5-8.

5-43. Decoder Drivers

5-44. The decoder drivers receive -8421 ($\overline{D}\overline{C}\overline{B}A$) BCD code from the buffer storage units on pins 9, 7, 8, and 10. This information is deciphered within the unit and provides an output to one of the 10 digital display tube elements. A low (about 2 V) to an element of the display tube will light that number. Numbers which are not lighted are held high (about 85 V). Refer to Table 5-9.

Table 5-7. Decade Counter Output

Decade Counters A4IC6, 9, 12, 15 Output H = High (>1.5V), L = Low (<0.4V)				
Digit	Pin Number			
	16	2	1	15
Blank	L	L	L	L
0	H	H	H	H
1	H	H	H	L
2	H	H	L	H
3	H	H	L	L
4	H	L	H	H
5	H	L	H	L
6	H	L	L	H
7	H	L	L	L
8	L	H	H	H
9	L	H	H	L

Table 5-6. High Frequency Decade Output

High Frequency Decade A4IC3 Output H = High (>1.5V), L = Low (<0.4V)				
Digit	Pin Number			
	1	8	7	6
0	H	H	H	H
1	H	H	H	L
2	H	H	L	H
3	H	H	L	L
4	H	L	H	H
5	H	L	H	L
6	H	L	L	H
7	H	L	L	L
8	L	H	H	H
9	L	H	H	L

Table 5-8. Buffer Storage Output

Buffer Storage Output: H=High (>2.1V); L=Low (<0.4V)				
Digit	Pin Number			
	16	3	1	14
Blank	L	L	L	L
0	H	H	H	H
1	H	H	H	L
2	H	H	L	H
3	H	H	L	L
4	H	L	H	H
5	H	L	H	L
6	H	L	L	H
7	H	L	L	L
8	L	H	H	H
9	L	H	H	L

Table 5-9. Decoder Driver

Decoder Driver (H = High, L = Low)																
Digit	Input L = < 0.4V, H = > 2.1V				10 Line Output H = > 55 V, L = < 3 V										Number Lighted
	Pin Number				Pin Number										
	9	7	8	10	1	2	3	4	11	12	13	14	15	16	
Blank	L	L	L	L	H	H	H	H	H	H	H	H	H	H	None
0	H	H	H	H	L	H	H	H	H	H	H	H	H	H	0
1	H	H	H	L	H	L	H	H	H	H	H	H	H	H	1
2	H	H	L	H	H	H	L	H	H	H	H	H	H	H	2
3	H	H	L	L	H	H	H	L	H	H	H	H	H	H	3
4	H	L	H	H	H	H	H	H	L	H	H	H	H	H	4
5	H	L	H	L	H	H	H	H	H	L	H	H	H	H	5
6	H	L	L	H	H	H	H	H	H	H	L	H	H	H	6
7	H	L	L	L	H	H	H	H	H	H	H	L	H	H	7
8	L	H	H	H	H	H	H	H	H	H	H	H	L	H	8
9	L	H	H	L	H	H	H	H	H	H	H	H	H	L	9

Figure 5-1. Model 5221B Side and Bottom Internal Views

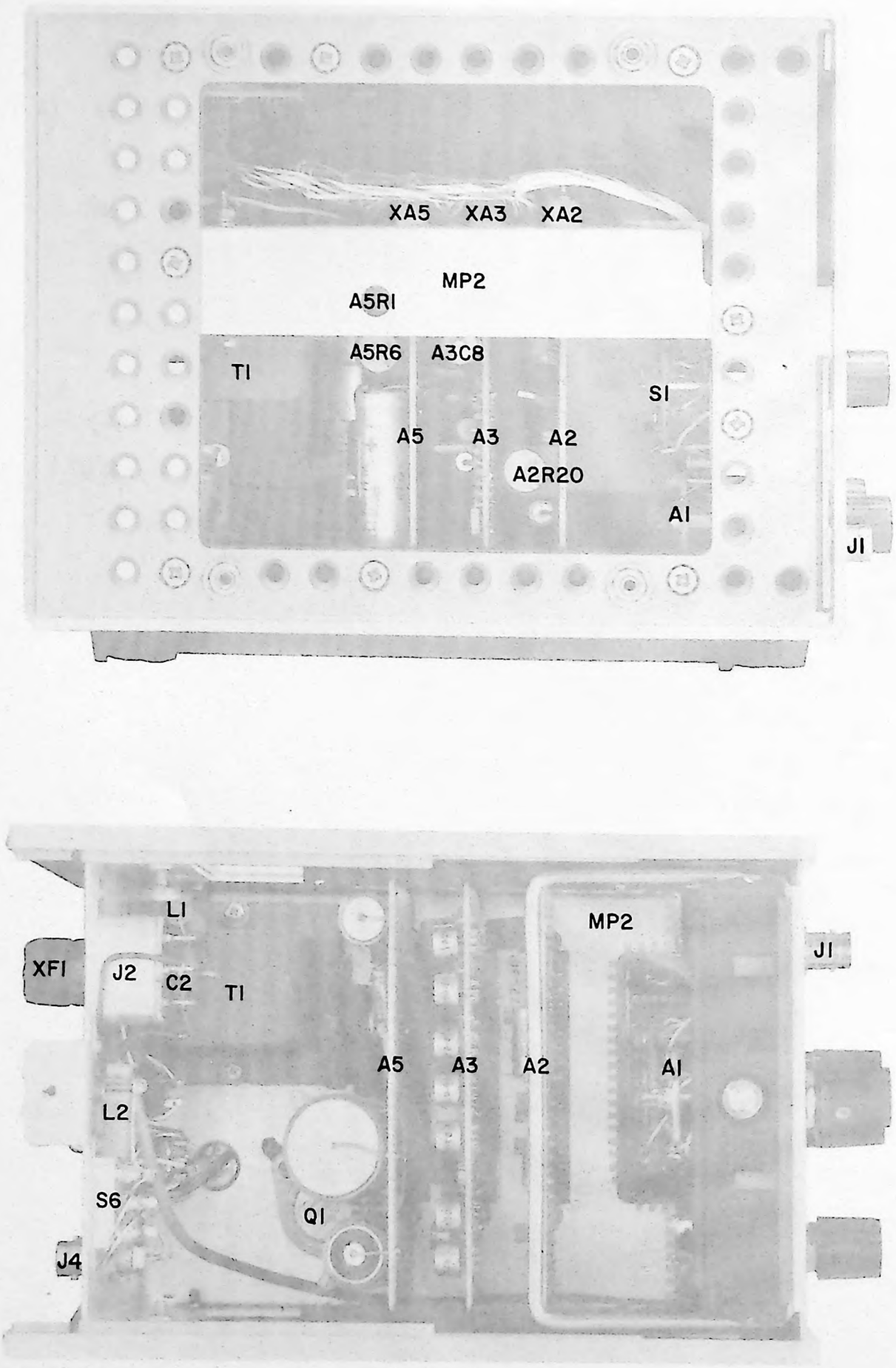
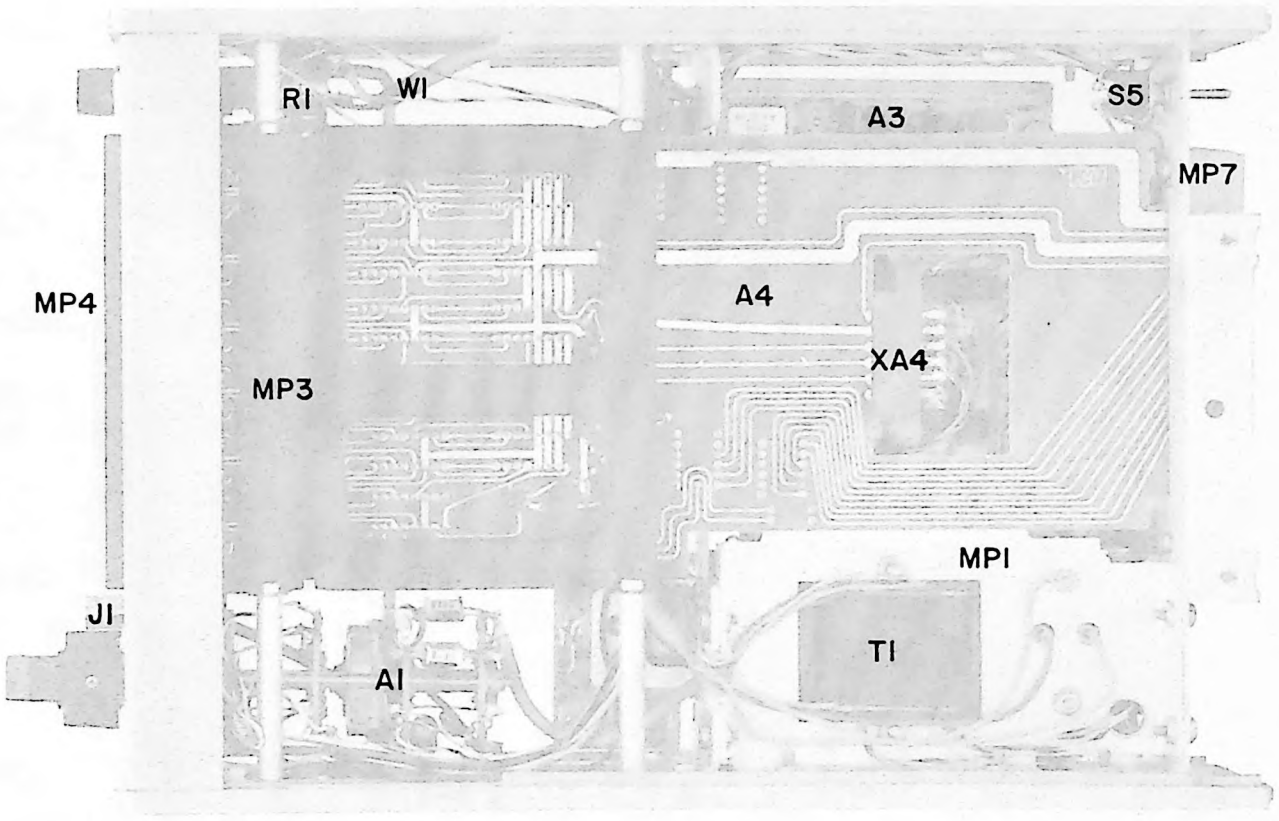
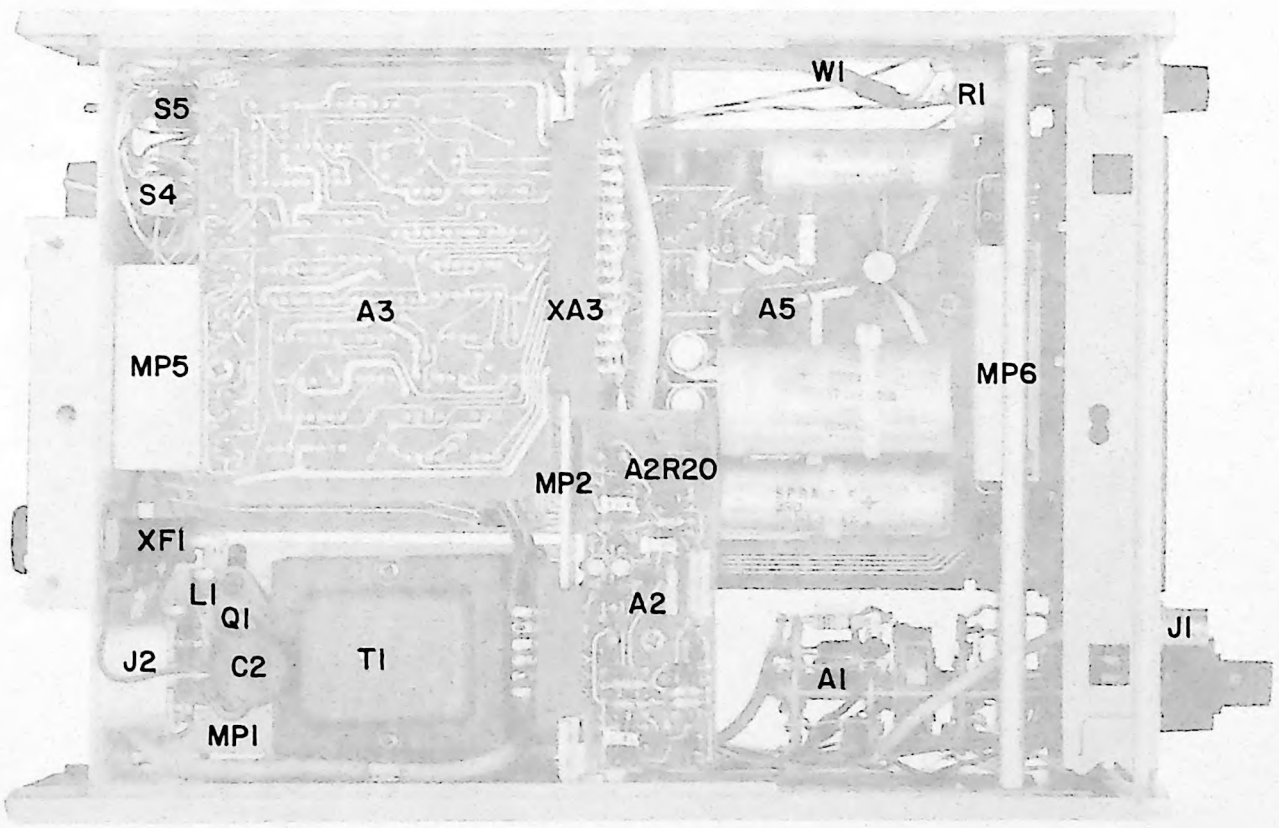


Figure 5-2. Model 5231B Top and Bottom Internal Views





SECTION VI

REPLACEABLE PARTS

6-1. INTRODUCTION

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alpha-numerical order of their reference designators and indicates the description and HP part number of each part, together with any applicable notes. Table 6-2 lists parts in alpha-numerical order of their HP part number and provides the following information on each part;

a. Description of part (see abbreviations below).

b. Typical manufacturer of the part in a five-digit code; see list of manufacturers in Table 6-3.

c. Manufacturer's part number.

d. Total quantity used in the instrument (TQ column).

6-3. Miscellaneous parts are listed at the end of Table 6-1.

6-4. ORDERING INFORMATION

6-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Sales and Service office (see lists at rear of this manual for addresses). Identify parts by their Hewlett-Packard part numbers.

6-6. To obtain a part that is not listed, include:

a. Instrument model number.

b. Instrument serial number.

c. Description of the part.

d. Function and location of the part.

REFERENCE DESIGNATORS

A = assembly	F = fuse	MP = mechanical part	V = vacuum, tube, neon bulb, photocell, etc.
B = motor	FL = filter	P = plug	
BT = battery	IC = integrated circuit	Q = transistor	VR = voltage regulator
C = capacitor	J = jack	R = resistor	W = cable
CP = coupler	K = relay	RT = thermistor	X = socket
CR = diode	L = inductor	S = switch	Y = crystal
DL = delay line	LS = loud speaker	T = transformer	Z = tuned cavity, network
DS = device signaling (lamp)	M = meter	TB = terminal board	
E = misc electronic part	MK = microphone	TP = test point	

ABBREVIATIONS

A = amperes	H = henries	N/O = normally open	RMO = rack mount only
AFC = automatic frequency control	HDW = hardware	NPO = negative positive zero (zero temperature coefficient)	RMS = root-mean square
AMPL = amplifier	HEX = hexagonal		RWV = reverse working voltage
	HG = mercury		
BFO = beat frequency oscillator	HR = hour(s)	NPN = negative-positive-negative	S-B = slow-blow
BE CU = beryllium copper	HZ = hertz		SCR = screw
BH = binder head		NRFR = not recommended for field replacement	SE = selenium
BP = bandpass	IF = intermediate freq		SECT = section(s)
BRS = brass	IMPG = impregnated	NSR = not separately replaceable	SEMICON = semiconductor
BWO = backward wave oscillator	INCD = incandescent		SI = silicon
	INCL = include(s)		SIL = silver
CCW = counter-clockwise	INS = insulation(ed)	OBD = order by description	SL = slide
CER = ceramic	INT = internal	OH = oval head	SPG = spring
CMO = cabinet mount only		OX = oxide	SPL = special
COEF = coefficient	K = kilo = 1000		SST = stainless steel
COM = common		P = peak	SR = split ring
COMP = composition	LH = left hand	PC = printed circuit	STL = steel
COMPL = complete	LIN = linear taper	PF = picofarads = 10^{-12} farads	TA = tantalum
CONN = connector	LK WASH = lock washer		TD = time delay
CP = cadmium plate	LOG = logarithmic taper	PH BRZ = phosphor bronze	TGL = toggle
CRT = cathode-ray tube	LPF = low pass filter	PHL = Phillips	THD = thread
CW = clockwise		PIV = peak inverse voltage	TI = titanium
	M = milli = 10^{-3}	PNP = positive-negative-positive	TOL = tolerance
DEPC = deposited carbon	MEG = meg = 10^{6}		TRIM = trimmer
DR = drive	MET FLM = metal film	P/O = part of	TWT = traveling wave tube
	MET OX = metallic oxide	POLY = polystyrene	
ELECT = electrolytic	MFR = manufacturer	PORC = porcelain	U = micro = 10^{-6}
ENCAP = encapsulated	MHZ = mega hertz	POS = position(s)	
EXT = external	MINAT = miniature	POT = potentiometer	VAR = variable
	MOM = momentary	PP = peak-to-peak	VDCW = dc working volts
F = farads	MTG = mounting	PT = point	
FH = flat head	MY = "mylar"	PWV = peak working voltage	W/ = with
FIL H = fillister head			W = watts
FXD = fixed	N = nano (10^{-9})	RECT = rectifier	WIV = working inverse voltage
	N/C = normally closed	RF = radio frequency	
G = giga (10^{9})	NE = neon	RH = round head or right hand	WW = wirewound
GE = germanium	NI PL = nickel plate		W/O = without
GL = glass			
GRD = ground(ed)			

01194-13

Table 6-1. Reference Designation Index

Reference Designation	℗ Part No.	Description #	Note
A1	05221-6025	SWITCH ASSY:ATTENUATOR (5221B ONLY)	
	05321-60009	SWITCH ASSY:ATTEN/GATE SELECTOR (5321B ONLY)	
A1C1		NOT ASSIGNED(5221B ONLY)	
	0170-0040	C:FXD MY .047 UF 10% 200VDCW (5321B ONLY)	
A1C2	0160-2261	C:FXD CER 15 PF 5% 500VDCW	
A1C3	0160-2262	C:FXD CER 16 PF 5% 500VDCW	
A1C4	0160-2257	C:FXD CER 10 PF 5% 500VDCW	
A1C5	0160-2257	C:FXD CER 10 PF 5% 500VDCW	
A1C6	0160-0945	C:FXD MICA 910 PF 5%	
A1C7	0160-2307	C:FXD MICA 47 PF 5%	
A1R1	0698-6788	R:FXD MET FLM 1 MEGOHM 1% 1/4W	
A1R2	0698-6787	R:FXD MET FLM 909K OHM 1% 1/4W	
A1R3	0757-0442	R:FXD MET FLM 10.0K OHM 1% 1/8W	
A1R4	0698-3451	R:FXD MET FLM 133K OHM 1% 1/8W	
A1R5	0683-1055	R:FXD COMP 1 MEGOHM 5% 1/4W	
A1S1	3100-2410	SWITCH:ROTARY (5221B ONLY)	
	3100-2425	SWITCH:ROTARY (5321B ONLY)	
A2	05221-6012	BOARD ASSY:AMPLIFIER/TRIGGER (5221B ONLY)	
	05221-2012	BOARD:BLANK PC	
	05221-6002	BOARD ASSY:AMPLIFIER/TRIGGER (5321B ONLY)	
	05221-2002	BOARD:BLANK PC	
A2C1	0160-2255	C:FXD CER 8.2±0.25PF 500VDCW	
A2C2	0180-0291	C:FXD ELECT 1UF 10% 35VDCW	
A2C3	0180-0229	C:FXD ELECT 33 UF 10% 10VDCW	
A2C4	0180-0137	C:FXD ELECT 100 UF 20% 10VDCW	
A2C5	0160-2250	C:FXD CER 5.1±0.25 PF 500VDCW	
A2C6	0180-0291	C:FXD ELECT 1UF 10% 35VDCW	
A2C7	0160-2257	C:FXD CER 10 PF 5% 500VDCW	
A2CR1	1901-0040	DIODE:SILICON 30MA 30WV	
A2CR2	1901-0040	DIODE:SILICON 30MA 30WV	
A2CR3	1901-0040	DIODE:SILICON 30MA 30WV	
A2Q1	1855-0053	TRANSISTOR:SILICON FET N CHANNEL	

 # See introduction to this section for ordering information

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	℗ Part No.	Description #	Note
A2Q2	1853-0036	TRANSISTOR:SILICON PNP	
A2Q3	1854-0215	TRANSISTOR:SILICON NPN 2N3904	
A2Q4	1853-0036	TRANSISTOR:SILICON PNP	
A2Q5	1854-0019	TRANSISTOR:SILICON NPN	
A2Q6	1854-0019	TRANSISTOR:SILICON NPN	
A2Q7	1854-0215	TRANSISTOR:SILICON NPN 2N3904	
A2Q8	1853-0036	TRANSISTOR:SILICON PNP	
A2Q9	1853-0036	TRANSISTOR:SILICON PNP	
A2R1	0683-5115	R:FXD COMP 510 OHM 5% 1/4W	
A2R2	0684-4711	R:FXD COMP 470 OHM 10% 1/4W	
A2R3	0757-0927	R:FXD MET FLM 1.3K OHM 2% 1/4W	
A2R4	0683-3925	R:FXD COMP 3900 OHM 5% 1/4W	
A2R5	0757-0934	R:FXD MET FLM 2.7K OHM 2% 1/4W	
A2R6	0757-0944	R:FXD MET FLM 6.8K OHM 2% 1/4W	
A2R7	0683-5615	R:FXD COMP 560 OHM 5% 1/4W	
A2R8	0757-0907	R:FXD MET FLM 200 OHM 2% 1/4W	
A2R9	0757-0925	R:FXD MET FLM 1.1K OHM 2% 1/4W	
A2R10	0757-0939	R:FXD MET FLM 4.3K OHM 2% 1/4W	
A2R11	0757-0934	R:FXD MET FLM 2.7K OHM 2% 1/4W	
A2R12	0757-0917	R:FXD MET FLM 510 OHM 2% 1/4W	
A2R13	0757-0924	R:FXD MET FLM 1.0K OHM 2% 1/4W	
A2R14	0757-0932	R:FXD MET FLM 2.2K OHM 2% 1/4W	
A2R15	0757-0920	R:FXD MET FLM 680 OHM 2% 1/4W	
A2R16	0683-6815	R:FXD COMP 680 OHM 5% 1/4W	
A2R17	0683-2025	R:FXD COMP 2000 OHM 5% 1/4W	
A2R18	0757-0912	R:FXD MET FLM 330 OHM 2% 1/4W	
A2R19	0683-9115	R:FXD COMP 910 OHM 5% 1/4W	
A2R20	2100-1756	R:VAR WW 200 OHM 10% LIN 1/2W	
A2R21	0683-2425	R:FXD COMP 2400 OHM 5% 1/4W	
A3	05221-6011	BOARD ASSY:OSCILLATOR/TIME BASE	
	05221-2011	BOARD:BLANK PC	
A3C1	0150-0121	C:FXD CER 0.1UF +80%-20% 50VDCW	
A3C2	0160-0127	C:FXD CER 1UF 20% 25VDCW	
A3C3	0160-0168	C:FXD MY 0.1 UF 10% 200VDCW	
A3C4	0160-0127	C:FXD CER 1UF 20% 25VDCW	
A3C5	0160-2143	C:FXD CER 2000 PF +80-20% 1000VDCW	
A3C6	0140-0194	C:FXD MICA 110 PF 5%	
A3C7	0160-2203	C:FXD MICA 91 PF 5%	
A3C8	0121-0180	C:VAR CER 15-60 PF	
A3C9	0140-0201	C:FXD MICA 12 PF 5%	
A3C10	0160-2218	C:FXD MICA 1000 PF 5%	
A3C11	0140-0149	C:FXD MICA 47 UUF 5%	
A3C12	0160-0298	C:FXD MY 0.0015 UF 10% 200VDCW	
A3C13	0140-0193	C:FXD MICA 82 PF 5%	

 # See introduction to this section for ordering information

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	℗ Part No.	Description #	Note
A3C14	0140-0193	C:FXD MICA 82 PF 5%	
A3C15	0180-0229	C:FXD ELECT 33 UF 10% 10VDCW	
A3C16	0150-0075	C:FXD CER 4700 PF +100-20% 500VDCW	
A3C17	0150-0093	C:FXD CER 0.01 UF +80-20% 100VDCW	
A3CR1	1910-0016	DIODE:GERMANIUM 100MA AT 0.85V 60PIV	
A3CR2	1910-0016	DIODE:GERMANIUM 100MA AT 0.85V 60PIV	
A3CR3	1901-0040	DIODE:SILICON 30MA 30WV	
A3CR4	1910-0016	DIODE:GERMANIUM 100MA AT 0.85V 60PIV	
A3CR5	1910-0016	DIODE:GERMANIUM 100MA AT 0.85V 60PIV	
A3CR6	1910-0016	DIODE:GERMANIUM 100MA AT 0.85V 60PIV	
A3CR7	1910-0016	DIODE:GERMANIUM 100MA AT 0.85V 60PIV	
A3CR8	1910-0016	DIODE:GERMANIUM 100MA AT 0.85V 60PIV	
A3CR9	1910-0016	DIODE:GERMANIUM 100MA AT 0.85V 60PIV	
A3CR10	1910-0016	DIODE:GERMANIUM 100MA AT 0.85V 60PIV	
A3CR11	1910-0016	DIODE:GERMANIUM 100MA AT 0.85V 60PIV	
A3CR12	1910-0016	DIODE:GERMANIUM 100MA AT 0.85V 60PIV	
A3CR13	1901-0081	DIODE:SILICON 50 VOLTS WORKING	
A3CR14	1910-0016	DIODE:GERMANIUM 100MA AT 0.85V 60PIV	
A3CR15	1910-0016	DIODE:GERMANIUM 100MA AT 0.85V 60PIV	
A3CR16	1901-0081	DIODE:SILICON 50 VOLTS WORKING	
A3CR17	1910-0016	DIODE:GERMANIUM 100MA AT 0.85V 60PIV	
A3CR18	1910-0016	DIODE:GERMANIUM 100MA AT 0.85V 60PIV	
A3CR19	1910-0016	DIODE:GERMANIUM 100MA AT 0.85V 60PIV	
A3CR20	1901-0081	DIODE:SILICON 50 VOLTS WORKING	
A3IC1	1820-0054	INTEGRATED CIRCUIT	
A3IC2	1820-0098	CIRCUIT:HP	
A3IC3	1820-0098	CIRCUIT:HP	
A3IC4	1820-0098	CIRCUIT:HP	
A3IC5	1820-0098	CIRCUIT:HP	
A3IC6	1820-0098	CIRCUIT:HP	
A3IC7	1820-0068	INTEGRATED CIRCUIT	
A3IC8	1820-0098	CIRCUIT:HP	
A3IC9	1820-0098	CIRCUIT:HP	
A3IC10	1820-0054	INTEGRATED CIRCUIT	
A3IC11	1820-0076	INTEGRATED CIRCUIT	
A3L1	9100-1661	COIL/CHOKE 2200 UH 5%	
A3Q1	1854-0071	TRANSISTOR:SILICON NPN	
A3Q2	1854-0071	TRANSISTOR:SILICON NPN	
A3Q3	1854-0071	TRANSISTOR:SILICON NPN	
A3Q4	1854-0071	TRANSISTOR:SILICON NPN	
A3Q5	1854-0071	TRANSISTOR:SILICON NPN	
A3Q6	1854-0071	TRANSISTOR:SILICON NPN	
A3Q7	1854-0071	TRANSISTOR:SILICON NPN	
A3Q8	1854-0232	TRANSISTOR:SILICON NPN	

 # See introduction to this section for ordering information

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	℗ Part No.	Description #	Note
A3R1	0683-3035	R:FXD COMP 30K OHM 5% 1/4W	
A3R2	0683-2035	R:FXD COMP 20K OHM 5% 1/4W	
A3R3	0683-1015	R:FXD COMP 100 OHM 5% 1/4W	
A3R4	0683-5115	R:FXD COMP 510 OHM 5% 1/4W	
A3R5	0683-1825	R:FXD COMP 1800 OHM 5% 1/4W	
A3R6	0683-1015	R:FXD COMP 100 OHM 5% 1/4W	
A3R7	0683-1015	R:FXD COMP 100 OHM 5% 1/4W	
A3R8	0683-3025	R:FXD COMP 3000 OHM 5% 1/4W	
A3R9	0683-3025	R:FXD COMP 3000 OHM 5% 1/4W	
A3R10	0683-1045	R:FXD COMP 100K OHMS 5% 1/4W	
A3R11	0683-2235	R:FXD COMP 22K OHM 5% 1/4W	
A3R12	0683-1035	R:FXD COMP 10K OHM 5% 1/4W	
A3R13	0683-1035	R:FXD COMP 10K OHM 5% 1/4W	
A3R14	0683-1525	R:FXD COMP 1500 OHM 5% 1/4W	
A3R15	0675-1021	R:FXD CARBON 1K OHM 10% 1/8W	
A3R16	0683-1025	R:FXD COMP 1000 OHM 5% 1/4W	
A3R17	0683-1015	R:FXD COMP 100 OHM 5% 1/4W	
A3R18	0675-1021	R:FXD CARBON 1K OHM 10% 1/8W	
A3R19	0675-1021	R:FXD CARBON 1K OHM 10% 1/8W	
A3R20	0675-1021	R:FXD CARBON 1K OHM 10% 1/8W	
A3R21	0675-1021	R:FXD CARBON 1K OHM 10% 1/8W	
A3R22	0675-1021	R:FXD CARBON 1K OHM 10% 1/8W	
A3R23	0675-1021	R:FXD CARBON 1K OHM 10% 1/8W	
A3R24	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A3R25	0683-5635	R:FXD COMP 56K OHMS 5% 1/4W	
A3R26	0683-5635	R:FXD COMP 56K OHMS 5% 1/4W	
A3R27	0683-2035	R:FXD COMP 20K OHM 5% 1/4W	
A3R28	0683-1035	R:FXD COMP 10K OHM 5% 1/4W	
A3R29	0683-1035	R:FXD COMP 10K OHM 5% 1/4W	
A3R30	0683-1515	R:FXD COMP 150 OHM 5% 1/4W	
A3R31	0683-1035	R:FXD COMP 10K OHM 5% 1/4W	
A3R32	0683-1035	R:FXD COMP 10K OHM 5% 1/4W	
A3R33	0683-1035	R:FXD COMP 10K OHM 5% 1/4W	
A3R34	0683-5635	R:FXD COMP 56K OHMS 5% 1/4W	
A3R35	0683-5635	R:FXD COMP 56K OHMS 5% 1/4W	
A3R36	0683-1025	R:FXD COMP 1000 OHM 5% 1/4W	
A3R37	0683-1035	R:FXD COMP 10K OHM 5% 1/4W	
A3R38	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A3R39	0683-4715	R:FXD COMP 470 OHM 5% 1/4W	
A3R40	0683-2735	R:FXD COMP 27K OHM 5% 1/4W	
A3R41	0683-3315	R:FXD COMP 330 OHM 5% 1/4W	
A3R42	0683-1525	R:FXD COMP 1500 OHM 5% 1/4W	
A3R43	0683-5635	R:FXD COMP 56K OHMS 5% 1/4W	
A3R44	0683-1045	R:FXD COMP 100K OHMS 5% 1/4W	
A3R45	0683-2035	R:FXD COMP 20K OHM 5% 1/4W	
A3Y1	0410-0142	CRYSTAL:QUARTZ 1.0 MHZ	

 # See introduction to this section for ordering information

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description #	Note
A4	05221-6013	BOARD ASSY:COUNTER (5221B ONLY)	
	05221-2013	BOARD:BLANK PC	
	05321-60001	BOARD ASSY:COUNTER (5321B ONLY)	
	05321-20001	BOARD:BLANK PC	
A4C1	0160-2055	C:FXD CER 0.01 UF +80-20% 100VDCW	
A4C2	0160-2257	C:FXD CER 10 PF 5% 500VDCW	
A4C3	0160-2250	C:FXD CER 5.1±0.25 PF 500VDCW	
A4C4	0160-2257	C:FXD CER 10 PF 5% 500VDCW	
A4CR1	1902-0197	DIODE BREAKDOWN:SILICON 82.5V 5%	
A4CR2	1902-0197	DIODE BREAKDOWN:SILICON 82.5V 5%	
A4CR3	1901-0025	DIODE:SILICON 100WV 100MA	
A4CR4	1901-0025	DIODE:SILICON 100WV 100MA	
A4CR5	1901-0025	DIODE:SILICON 100WV 100MA	
A4CR6	1901-0025	DIODE:SILICON 100WV 100MA	
A4CR7	1901-0025	DIODE:SILICON 100WV 100MA	
A4DS1	1970-0025	DIGITAL DISPLAY TUBE	
A4DS2	1970-0025	DIGITAL DISPLAY TUBE	
A4DS3	1970-0025	DIGITAL DISPLAY TUBE	
A4DS4	1970-0025	DIGITAL DISPLAY TUBE	
A4DS5	1970-0025	DIGITAL DISPLAY TUBE	
A4IC1	1820-0092	CIRCUIT:HP 5084-0004	
A4IC2	1820-0116	INTEGRATED CIRCUIT	
A4IC3	1820-0079	CIRCUIT:HP	
A4IC4	1820-0092	CIRCUIT:HP	
A4IC5	1820-0116	INTEGRATED CIRCUIT	
A4IC6	1820-0093	CIRCUIT:HP	
A4IC7	1820-0092	CIRCUIT:HP	
A4IC8	1820-0116	INTEGRATED CIRCUIT	
A4IC9	1820-0093	CIRCUIT:HP	
A4IC10	1820-0092	CIRCUIT:HP	
A4IC11	1820-0116	INTEGRATED CIRCUIT	
A4IC12	1820-0093	CIRCUIT:HP	
A4IC13	1820-0092	CIRCUIT:HP	
A4IC14	1820-0116	INTEGRATED CIRCUIT	
A4IC15	1820-0093	CIRCUIT:HP	
A4Q1	1854-0009	TRANSISTOR:SILICON NPN 2N709	
A4Q2	1854-0009	TRANSISTOR:SILICON NPN 2N709	
A4Q3	1854-0009	TRANSISTOR:SILICON NPN 2N709	
A4Q4	1854-0009	TRANSISTOR:SILICON NPN 2N709	

 # See introduction to this section for ordering information

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	℗ Part No.	Description #	Note
A4R1	0683-2035	R:FXD COMP 20K OHM 5% 1/4W	
A4R2	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A4R3	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A4R4	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A4R5	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A4R6	0683-2035	R:FXD COMP 20K OHM 5% 1/4W	
A4R7	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A4R8	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A4R9	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A4R10	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A4R11	0683-2035	R:FXD COMP 20K OHM 5% 1/4W	
A4R12	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A4R13	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A4R14	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A4R15	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A4R16	0683-2035	R:FXD COMP 20K OHM 5% 1/4W	
A4R17	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A4R18	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A4R19	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A4R20	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A4R21	0683-1025	R:FXD COMP 1000 OHM 5% 1/4W	
A4R22	0683-2035	R:FXD COMP 20K OHM 5% 1/4W	
A4R23	0683-5115	R:FXD COMP 510 OHM 5% 1/4W	
A4R24	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A4R25	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A4R26	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A4R27	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A4R28	0683-5115	R:FXD COMP 510 OHM 5% 1/4W	
A4R29	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A4R30	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A4R31	0683-4325	R:FXD COMP 4300 OHM 5% 1/4W	
A4R32		NOT ASSIGNED	
A4R33	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A4R34-A4R36		NOT ASSIGNED	
A4R37	0683-5115	R:FXD COMP 510 OHM 5% 1/4W	
A4R38		NOT ASSIGNED	
A4R39	0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	
A5	05221-6010	BOARD ASSY:POWER SUPPLY	
	05221-2010	BOARD:BLANK PC	
A5C1	0180-2102	C:FXD ELECT 700 UF +75-10% 25VDCW	
A5C2	0180-2101	C:FXD ELECT 4000 UF +75-10% 15VDCW	
A5C3	0180-1780	C:FXD ELECT 500 UF +75-10% 10VDCW	

 # See introduction to this section for ordering information

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	Part No.	Description #	Note
A5C4	0180-0032	C:FXD ELECT 10 UF +75-10% 12VDCW	
A5C5	0180-0032	C:FXD ELECT 10 UF +75-10% 12VDCW	
A5C6	0150-0093	C:FXD CER 0.01 UF +80-20% 100VDCW	
A5CR1	1901-0028	DIODE:SILICON 400 PIV 0.5 AMP	
A5CR2	1901-0028	DIODE:SILICON 400 PIV 0.5 AMP	
A5CR3	1901-0028	DIODE:SILICON 400 PIV 0.5 AMP	
A5CR4	1901-0028	DIODE:SILICON 400 PIV 0.5 AMP	
A5CR5	1901-0049	DIODE:SILICON 50PIV	
A5CR6	1901-0049	DIODE:SILICON 50PIV	
A5CR7	1901-0049	DIODE:SILICON 50PIV	
A5CR8	1901-0049	DIODE:SILICON 50PIV	
A5CR9	1901-0200	DIODE:SILICON 100 PIV 3A	
A5CR10	1901-0200	DIODE:SILICON 100 PIV 3A	
A5CR11	1901-0200	DIODE:SILICON 100 PIV 3A	
A5CR12	1901-0200	DIODE:SILICON 100 PIV 3A	
A5CR13	1902-3036	DIODE BREAKDOWN:SILICON 3.16V	
A5CR14	1902-3036	DIODE BREAKDOWN:SILICON 3.16V	
A5CR15	1902-0031	DIODE BREAKDOWN:12.7V 5%	
A5CR16	1902-3036	DIODE BREAKDOWN:SILICON 3.16V	
A5CR17	1902-3059	DIODE BREAKDOWN:SILICON 3.83V 5%	
A5Q1	1854-0039	TRANSISTOR:SILICON 2N3053	
	1205-0050	HEAT DISSIPATOR	
A5Q2	1854-0232	TRANSISTOR:SILICON NPN	
	1205-0061	HEAT DISSIPATOR SEMICONDUCTOR	
A5Q3	1854-0071	TRANSISTOR:SILICON NPN	
A5Q4	1854-0071	TRANSISTOR:SILICON NPN	
A5R1	2100-1758	R:VAR WW 1K OHM 10% LIN 1/2W	
A5R2	0686-5135	R:FXD COMP 51K OHM 5% 1/2W	
A5R3	0683-6815	R:FXD COMP 680 OHM 5% 1/4W	
A5R4	0758-0022	R:FXD MET OX 82K OHM 5% 1/2W	
A5R5	0683-1315	R:FXD COMP 130 OHM 5% 1/4W	
A5R6	2100-1756	R:VAR WW 200 OHM 10% LIN 1/2W	
A5R7	0683-3615	R:FXD COMP 360 OHM 5% 1/4W	
A5R8	0683-1315	R:FXD COMP 130 OHM 5% 1/4W	
A5R9	0683-1055	R:FXD COMP 1 MEGOHM 5% 1/4W	
A5R10	0683-1055	R:FXD COMP 1 MEGOHM 5% 1/4W	
A5R11	0683-5145	R:FXD COMP 510K OHM 5% 1/4W	
A5RT1	0839-0021	THERMISTOR:DISC 500 OHM 10%	
C1	0170-0040	C:FXD MY .047 UF 10% 200VDCW (5221B ONLY)	
C2	0150-0119	C:FXD CER 2 X 0.01 UF 20% 250WVAC	
CR1	1902-3428	DIODE BREAKDOWN:SILICON 100V 5%	
DS1	2140-0018	LAMP:GLOW 1/10W	
F1	2110-0017	FUSE:CARTRIDGE 0.15 AMP SLOW BLOW (230 V OPERATION)	
F1	2110-0018	FUSE:CARTRIDGE 0.25 AMP SLOW BLOW (115 V OPERATION)	

 # See introduction to this section for ordering information

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	℗ Part No.	Description #	Note
J1	1250-0083	CONNECTOR:BNC	
J2	1251-0148	CONNECTOR:POWER 3 PIN MALE	
J3	1250-0083	CONNECTOR:BNC	
J4	1250-0083	CONNECTOR:BNC	
L1	9140-0136	COIL:FXD RF 22 UH	
L2	9140-0136	COIL:FXD RF 22 UH	
MP1	05210-4001	GUIDE:BOARD (5221B ONLY)	
MP1	05321-00001	CHASSIS:POWER SUPPLY (5321B ONLY)	
MP2	05221-0010	CHASSIS (5221B ONLY)	
MP2	05321-00004	CHASSIS:MAIN (5321B ONLY)	
MP3	05221-4001	CASE:COUNTER(BLACK PLASTIC)	
MP4	05221-4003	WINDOW (5221B ONLY)	
MP4	05321-40001	WINDOW (5321B ONLY)	
MP5	05221-0004	SPACER:FRONT PANEL (5221B ONLY)	
MP5	05321-00005	BRACKET:TIME BASE BOARD (5321B ONLY)	
MP6	05321-00006	BRACKET:POWER SUPPLY BOARD (5321B ONLY)	
MP7	05216-4007	GUARD:CONNECTOR(DIGITAL RECORDER)	
MP8	05216-4008	COVER:CONNECTOR(DIGITAL RECORDER)	
Q1	1854-0063	TRANSISTOR:NPN SILICON 2N3055	
	1200-0043	INSULATOR:TRANSISTOR MOUNTING	
R1	2100-0318	R:VAR 250K OHM 20% 1/4W/SPST SW (5221B ONLY)	
	0370-0103	KNOB:BLK W/ARROW 5/8 IN. OD 1/4 IN. SHAFT (5221B ONLY)	
R1	2100-2573	R:VAR COMP 250K OHM 20% LIN 1/4W (5321B ONLY)	
	0370-0102	KNOB:RED BAR (5321B ONLY)	
S1	3100-2411	SWITCH:ROTARY 2 SECTIONS (5221B ONLY) GATE SELECTOR	
	0370-0077	KNOB:5/8 SK BAR (5221B ONLY)	
		NOT ASSIGNED(5321B ONLY)	
S2		NOT ASSIGNED	
S3	3101-0052	SWITCH:PUSHBUTTON SPST RESET	
S4	3101-0957	SWITCH:TOGGLE DPDT	

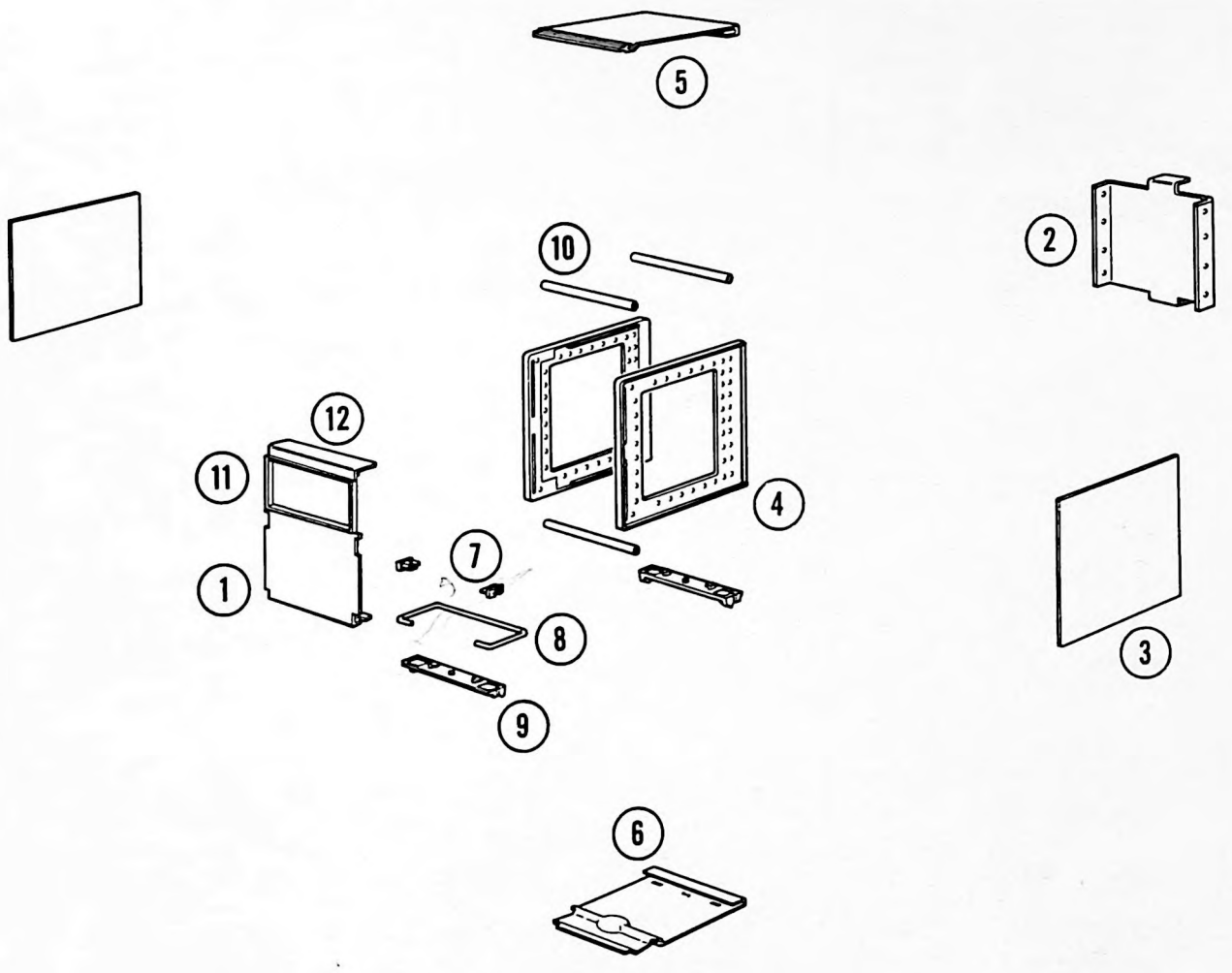
 # See introduction to this section for ordering information

Table 6-1. Reference Designation Index (Cont'd)

Reference Designation	℗ Part No.	Description #	Note
S5	3101-0957	SWITCH:TOGGLE DPDT	
S6	3101-0033	SWITCH:SLIDE DPDT	
		LINE VOLTAGE	
T1	9100-2438	TRANSFORMER	
W1	05221-6015	CABLE ASSY:POWER (5221B ONLY)	
W1	05321-60003	CABLE ASSY:POWER (5321B ONLY)	
W2	05221-6016	CABLE ASSY:SAMPLE RATE (5221B ONLY)	
W2	05321-60002	CABLE ASSY:AMPLIFIER OUTPUT (5321B ONLY)	
W3	8120-0078	CABLE ASSY:POWER CORD	
W4	05221-6014	CABLE ASSY:MAIN (5221B ONLY)	
W4	05321-60004	CABLE ASSY:RF INPUT (5321B ONLY)	
W5	05321-60005	CABLE ASSY:TIME BASE (5321B ONLY)	
W6	05321-60006	CABLE ASSY:COUNTER BOARD (5321B ONLY)	
W7	05321-60007	CABLE ASSY:ATTEN/GATE SELECTOR SWITCH (5321B ONLY)	
XA2	1251-0135	CONNECTOR:15 CONTACT (5221B ONLY)	
XA2	1251-0158	CONNECTOR:6-CONTACT (5321B ONLY)	
XA3	1251-0159	CONNECTOR:30 CONTACT	
XA4	1251-0493	CONNECTOR:PC 12 CONTACTS	
XA5	1251-0135	CONNECTOR:15 CONTACT (5221B ONLY)	
XA5	1251-0194	CONNECTOR:PRINTED CIRCUIT 15-CONTACT (5321B ONLY)	
	5000-0230	INSULATOR:P.C. BOARD (5321B ONLY)	
XDS1	5040-0234	LAMPHOLDER	
	5040-0235	BASE:LAMPHOLDER	
XF1	1400-0084	FUSEHOLDER:EXTRACTOR POST TYPE	
	0900-0016	"O" RING:11/16"	
	2190-0037	WASHER:LOCK SST FOR 1/2 THREAD	
	2950-0038	NUT:HEX SST 1/2-24 X 11/16	
		MISCELLANEOUS	
	0370-0077	KNOB:5/8" SKIRTED BAR	
	0370-0099	KNOB:5/8" SKIRTED BAR	
	0370-0134	KNOB:ROUND RED 1/2" DIA	

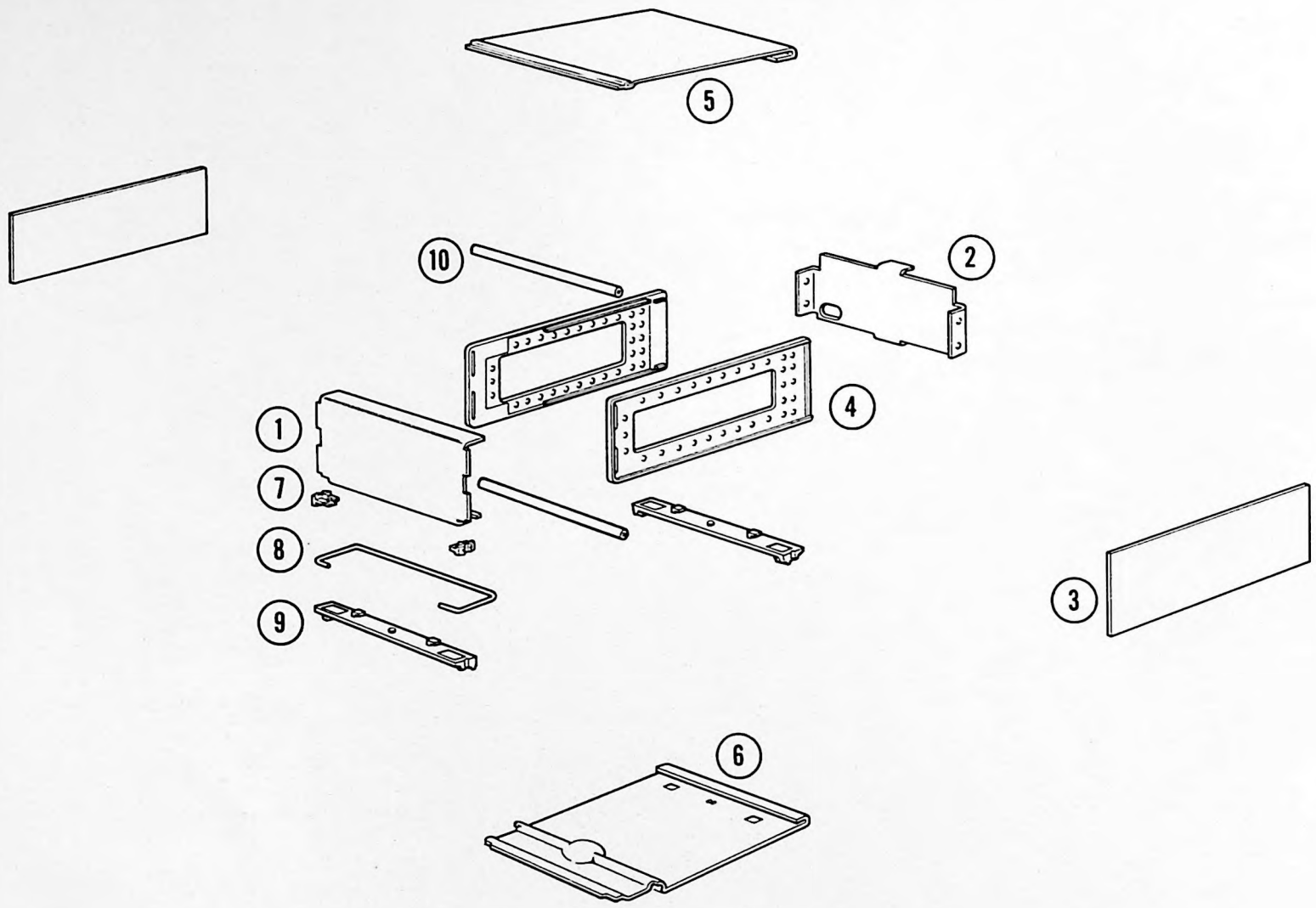
 # See introduction to this section for ordering information

Figure 6-1. Model 5221A Cabinet Parts



Item	Description	HP Part No.	Quantity
1.	Front Panel	05221-0012	1
2.	Rear Panel	05221-0011	1
3.	Side Cover	5000-0702	2
4.	Side Frame	5060-0702	2
5.	Top Cover	5060-0714	1
6.	Bottom Cover	5000-0713	1
7.	Hinge	5040-0700	2
8.	Tilt Stand	1490-0031	1
9.	Foot Assembly	5060-0727	2
10.	Spacer	5020-0700	3
11.	Window Frame	05221-4002	1
12.	Trim, Top Front	05221-0013	1

Figure 6-2. Model 5321A Cabinet Parts



Item	Description	HP Part No.	Quantity
1.	Front Panel	05321-00003	1
2.	Rear Panel	05321-00002	1
3.	Side Cover	5000-0700	2
4.	Side Frame	5060-0700	2
5.	Top Cover	5060-0724	1
6.	Bottom Cover	5000-0719	1
7.	Hinge	5040-0700	2
8.	Tilt Stand	1490-0032	1
9.	Foot Assembly	5060-0728	2
10.	Spacer	5020-0701	2

Table 6-2. Replaceable Parts

℗ Part No.	Description #	Mfr.	Mfr. Part No.	TQ		
				5221		5231
0121-0180	C:VAR CER 15-60 PF	28480	0121-0180	1		1
0140-0149	C:FXD MICA 47 UUF 5%	28480	0140-0149	1		1
0140-0193	C:FXD MICA 82 PF 5%	28480	0140-0193	2		2
0140-0194	C:FXD MICA 110 PF 5%	28480	0140-0194	1		1
0140-0201	C:FXD MICA 12 PF 5%	28480	0140-0201	1		1
0150-0075	C:FXD CER 4700 PF +100-20% 500VDCW	72982	851-000-X5U0-472Z	1		1
0150-0093	C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA	2		2
0150-0119	C:FXD CER 2 X 0.01 UF 20% 250WVAC	56289	36C219A	1		1
0150-0121	C:FXD CER 0.1UF +80%-20% 50VDCW	56289	5C50A	1		1
0160-0127	C:FXD CER 1UF 20% 25VDCW	56289	5C13	2		2
0160-0168	C:FXD MY 0.1 UF 10% 200VDCW	28480	0160-0168	1		1
0160-0298	C:FXD MY 0.0015 UF 10% 200VDCW	56289	192P15292-PTS	1		1
0160-0945	C:FXD MICA 910 PF 5%	28480	0160-0945	1		1
0160-2055	C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA	1		1
0160-2143	C:FXD CER 2000 PF +80-20% 1000VDCW	91418	TYPE B	1		1
0160-2203	C:FXD MICA 91 PF 5%	28480	0160-2203	1		1
0160-2218	C:FXD MICA 1000 PF 5%	28480	0160-2218	1		1
0160-2250	C:FXD CER 5.1±0.25 PF 500VDCW	72982	301-000-C0H0-519E	2		2
0160-2255	C:FXD CER 8.2±0.25PF 500VDCW	72982	301-NP0-8.2 PF	1		1
0160-2257	C:FXD CER 10 PF 5% 500VDCW	72982	301-000-C0H0-100J	5		5
0160-2261	C:FXD CER 15 PF 5% 500VDCW	72982	301-NP0-15 PF	1		1
0160-2262	C:FXD CER 16 PF 5% 500VDCW	72982	301-NP0-16PF	1		1
0160-2307	C:FXD MICA 47 PF 5%	28480	0160-2307	1		1
0170-0040	C:FXD MY .047 UF 10% 200VDCW	28480	0170-0040	1		1
0180-0032	C:FXD ELECT 10 UF +75-10% 12VDCW	28480	0180-0032	2		2
0180-0137	C:FXD ELECT 100 UF 20% 10VDCW	28480	0180-0137	1		1
0180-0229	C:FXD ELECT 33 UF 10% 10VDCW	28480	0180-0229	2		2
0180-0291	C:FXD ELECT 1UF 10% 35VDCW	56289	150D105X9035A2	2		2
0180-1780	C:FXD ELECT 500 UF +75-10% 10VDCW	28480	0180-1780	1		1
0180-2101	C:FXD ELECT 4000 UF +75-10% 15VDCW	28480	0180-2101	1		1
0180-2102	C:FXD ELECT 700 UF +75-10% 25VDCW	28480	0180-2102	1		1
0370-0077	KNOB:5/8" SKIRTED BAR	28480	0370-0077	1		1
0370-0099	KNOB:5/8" SKIRTED BAR	28480	0370-0099	1		1
0370-0102	KNOB:RED BAR	28480	0370-0102			1
0370-0103	KNOB BLK W/ARROW 5/8"OD 1/4"SHAFT	28480	0370-0103	1		
0370-0134	KNOB:ROUND RED 1/2" DIA	28480	0370-0134	1		1
0410-0142	CRYSTAL:QUARTZ 1.0 MHZ	28480	0410-0142	1		1
0675-1021	R:FXD CARBON 1K OHM 10% 1/8W	28480	0675-1021	7		7
0683-1015	R:FXD COMP 100 OHM 5% 1/4W	01121	CB 1015	4		4
0683-1025	R:FXD COMP 1000 OHM 5% 1/4W	01121	CB 1025	3		3
0683-1035	R:FXD COMP 10K OHM 5% 1/4W	01121	CB 1035	8		8
0683-1045	R:FXD COMP 100K OHMS 5% 1/4W	01121	CB 1045	2		2
0683-1055	R:FXD COMP 1 MEGOHM 5% 1/4W	01121	CB 1055	3		3
0683-1315	R:FXD COMP 130 OHM 5% 1/4W	01121	CB 1315	2		2
0683-1515	R:FXD COMP 150 OHM 5% 1/4W	01121	CB 1515	1		1
0683-1525	R:FXD COMP 1500 OHM 5% 1/4W	01121	CB 1525	2		2
0683-1825	R:FXD COMP 1800 OHM 5% 1/4W	01121	CB 1825	1		1
0683-2025	R:FXD COMP 2000 OHM 5% 1/4W	01121	CB 2025	1		1
0683-2035	R:FXD COMP 20K OHM 5% 1/4W	01121	CB 2035	8		8
0683-2235	R:FXD COMP 22K OHM 5% 1/4W	01121	CB 2235	1		1
0683-2425	R:FXD COMP 2400 OHM 5% 1/4W	01121	CB 2425	1		1
0683-2735	R:FXD COMP 27K OHM 5% 1/4W	01121	CB 2735	1		1
0683-3025	R:FXD COMP 3000 OHM 5% 1/4W	01121	CB 3025	2		2
0683-3035	R:FXD COMP 30K OHM 5% 1/4W	01121	CB 3035	1		1
0683-3315	R:FXD COMP 330 OHM 5% 1/4W	01121	CB 3315	1		1
0683-3615	R:FXD COMP 360 OHM 5% 1/4W	01121	CB 3615	1		1

 # See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont'd)

℗ Part No.	Description #	Mfr.	Mfr. Part No.	TQ		
				5221		5321
0683-3925	R:FXD COMP 3900 OHM 5% 1/4W	01121	CB 3925	1		1
0683-4325	R:FXD COMP 4300 OHM 5% 1/4W	01121	CB 4325	1		1
0683-4715	R:FXD COMP 470 OHM 5% 1/4W	01121	CB 4715	1		1
0683-5115	R:FXD COMP 510 OHM 5% 1/4W	01121	CB 5115	5		5
0683-5125	R:FXD COMP 5100 OHM 5% 1/4W	01121	CB 5125	26		26
0683-5145	R:FXD COMP 510K OHM 5% 1/4W	01121	CB 5145	1		1
0683-5615	R:FXD COMP 560 OHM 5% 1/4W	01121	CB 5615	1		1
0683-5635	R:FXD COMP 56K OHMS 5% 1/4W	01121	CB 5635	5		5
0683-6815	R:FXD COMP 680 OHM 5% 1/4W	01121	CB 6815	2		2
0683-9115	R:FXD COMP 910 OHM 5% 1/4W	01121	CB 9115	1		1
0684-4711	R:FXD COMP 470 OHM 10% 1/4W	01121	CB 4711	1		1
0686-5135	R:FXD COMP 51K OHM 5% 1/2W	01121	EB 5135	1		1
0698-3451	R:FXD MET FLM 133K OHM 1% 1/8W	28480	0698-3451	1		1
0698-6787	R:FXD MET FLM 909K OHM 1% 1/4W	75042	CEB T-0	1		1
0698-6788	R:FXD MET FLM 1 MEGOHM 1% 1/4W	75042	CEB T-0	1		1
0757-0442	R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442	1		1
0757-0907	R:FXD MET FLM 200 OHM 2% 1/4W	28480	0757-0907	1		1
0757-0912	R:FXD MET FLM 330 OHM 2% 1/4W	28480	0757-0912	1		1
0757-0917	R:FXD MET FLM 510 OHM 2% 1/4W	28480	0757-0917	1		1
0757-0920	R:FXD MET FLM 680 OHM 2% 1/4W	28480	0757-0920	1		1
0757-0924	R:FXD MET FLM 1.0K OHM 2% 1/4W	28480	0757-0924	1		1
0757-0925	R:FXD MET FLM 1.1K OHM 2% 1/4W	28480	0757-0925	1		1
0757-0927	R:FXD MET FLM 1.3K OHM 2% 1/4W	28480	0757-0927	1		1
0757-0932	R:FXD MET FLM 2.2K OHM 2% 1/4W	28480	0757-0932	1		1
0757-0934	R:FXD MET FLM 2.7K OHM 2% 1/4W	28480	0757-0934	2		2
0757-0939	R:FXD MET FLM 4.3K OHM 2% 1/4W	28480	0757-0939	1		1
0757-0944	R:FXD MET FLM 6.8K OHM 2% 1/4W	28480	0757-0944	1		1
0758-0022	R:FXD MET OX 82K OHM 5% 1/2W	28480	0758-0022	1		1
0839-0021	THERMISTOR:DISC 500 OHM 10%	83186	25E11	1		1
0900-0016	"O" RING:11/16"	28480	0900-0016	1		1
1200-0043	INSULATOR:TRANSISTOR MOUNTING	71785	293011	1		1
1205-0050	HEAT DISSIPATOR	28480	1205-0050	1		1
1205-0061	HEAT DISSIPATOR SEMICONDUCTOR	28480	1205-0061	1		1
1250-0083	CONNECTOR:BNC	28480	1250-0083	3		3
1251-0135	CONNECTOR:15 CONTACT	28480	1251-0135	2		
1251-0148	CONNECTOR:POWER 3 PIN MALE	87930	1065-1	1		1
1251-0158	CONNECTOR:6-CONTACT	28480	1251-0158			1
1251-0159	CONNECTOR:30 CONTACT	28480	1251-0159	1		1
1251-0194	CONNECTOR:PRINTED CIRCUIT 15-CONTACT	28480	1251-0194			1
1251-0493	CONNECTOR:PC 12 CONTACTS	28480	1251-0493	1		1
1400-0084	FUSEHOLDER:EXTRACTOR POST TYPE	79515	342014	1		1
1820-0054	INTEGRATED CIRCUIT	28480	1820-0054	2		2
1820-0068	INTEGRATED CIRCUIT	28480	1820-0068	1		1
1820-0076	INTEGRATED CIRCUIT	28480	1820-0076	1		1
1820-0079	CIRCUIT:HP	28480	1820-0079	1		1
1820-0092	CIRCUIT:HP	28480	1820-0092	5		5
1820-0093	CIRCUIT:HP	28480	1820-0093	4		4
1820-0098	CIRCUIT:HP	28480	1820-0098	7		7
1820-0116	INTEGRATED CIRCUIT	28480	1820-0116	5		5
1853-0036	TRANSISTOR:SILICON PNP	28480	1853-0036	4		4
1854-0009	TRANSISTOR:SILICON NPN 2N709	07263	2N709	4		4
1854-0019	TRANSISTOR:SILICON NPN	28480	1854-0019	2		2
1854-0039	TRANSISTOR:SILICON 2N3053	02735	2N3053	1		1
1854-0063	TRANSISTOR:NPN SILICON 2N3055	02735	2N3055	1		1
1854-0071	TRANSISTOR:SILICON NPN	28480	1854-0071	9		9

 # See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont'd)

℗ Part No.	Description #	Mfr.	Mfr. Part No.	TQ 5221		5321
1854-0215	TRANSISTOR:SILICON NPN 2N3904	28480	1854-0215	2		2
1854-0232	TRANSISTOR:SILICON NPN	28480	1854-0232	2		2
1855-0053	TRANSISTOR:SILICON FET N CHANNEL	28480	1855-0053	1		1
1901-0025	DIODE:SILICON 100WV 100MA	28480	1901-0025	5		5
1901-0028	DIODE:SILICON 400 PIV 0.5 AMP	28480	1901-0028	4		4
1901-0040	DIODE:SILICON 30MA 30WV	28480	1901-0040	4		4
1901-0049	DIODE:SILICON 50PIV	28480	1901-0049	4		4
1901-0081	DIODE:SILICON 50 VOLTS WORKING	28480	1901-0081	3		3
1901-0200	DIODE:SILICON 100 PIV 3A	02735	1N4998	4		4
1902-0031	DIODE BREAKDOWN:12.7V 5%	28480	1902-0031	1		1
1902-0197	DIODE BREAKDOWN:SILICON 82.5V 5%	28480	1902-0197	2		2
1902-3036	DIODE BREAKDOWN:SILICON 3.16V	28480	1902-3036	3		3
1902-3059	DIODE BREAKDOWN:SILICON 3.83V 5%	28480	1902-3059	1		1
1902-3428	DIODE BREAKDOWN:SILICON 100V 5%	28480	1902-3428	1		1
1910-0016	DIODE:GERMANIUM 100MA AT 0.85V 60PIV	28480	1910-0016	16		16
1970-0025	ELECTRON TUBE	28480	1970-0025	5		5
2100-0318	R:VAR 250K OHM 20% 1/4W/SPST SW	28480	2100-0318	1		
2100-1756	R:VAR WW 200 OHM 10% LIN 1/2W	28480	2100-1756	2		2
2100-1758	R:VAR WW 1K OHM 10% LIN 1/2W	28480	2100-1758	1		1
2100-2573	R:VAR COMP 250K OHM 20% LIN 1/4W	28480	2100-2573			1
2110-0017	FUSE:CARTRIDGE 0.15 AMP SLOW BLOW	75915	313.150	1		1
2110-0018	FUSE:CARTRIDGE 0.25 AMP SLOW BLOW	75915	313.250	1		1
2140-0018	LAMP:GLOW 1/10W	24455	NE 2E1	1		1
2190-0037	WASHER:LOCK SST FOR 1/2 THREAD	78189	1224-08	1		1
2950-0038	NUT:HEX SST 1/2-24 X 11/16	75915	903-12	1		1
3100-2410	SWITCH:ROTARY	28480	3100-2410	1		
3100-2411	SWITCH:ROTARY 2 SECTIONS	28480	3100-2411	1		
3100-2425	SWITCH:ROTARY	28480	3100-2425			1
3101-0033	SWITCH:SLIDE DPDT	79727	6510 C	1		1
3101-0052	SWITCH:PUSHBUTTON SPST	82389	961 LESS HWD	1		1
3101-0957	SWITCH:TOGGLE DPDT	28480	3101-0957	2		2
5000-0230	INSULATOR:P.C. BOARD	28480	5000-0230			1
5040-0234	LAMPHOLDER	28480	5040-0234	1		1
5040-0235	BASE:LAMPHOLDER	28480	5040-0235	1		1
8120-0078	CABLE ASSY:POWER CORD	28480	8120-0078	1		1
9100-1661	COIL/CHOKE 2200 UH 5%	28480	9100-1661	1		1
9100-2438	TRANSFORMER	28480	9100-2438	1		1
9140-0136	COIL:FXD RF 22 UH	28480	9140-0136	2		2
05210-4001	GUIDE:BOARD	28480	05210-4001	1		
05216-4007	GUARD:CONNECTOR(DIGITAL RECORDER)	28480	05216-4007	1		1
05216-4008	COVER:CONNECTOR(DIGITAL RECORDER)	28480	05216-4008	1		1
05221-0004	SPACER:FRONT PANEL	28480	05221-0004	1		
05221-0010	CHASSIS	28480	05221-0010	1		
05221-2002	BOARD:BLANK PC	28480	05221-2002			1
05221-2010	BOARD:BLANK PC	28480	05221-2010	1		1
05221-2011	BOARD:BLANK PC	28480	05221-2011	1		1
05221-2012	BOARD:BLANK PC	28480	05221-2012	1		
05221-2013	BOARD:BLANK PC	28480	05221-2013	1		
05221-4001	CASE:COUNTER(BLACK PLASTIC)	28480	05221-4001	1		1
05221-4003	WINDOW	28480	05221-4003	1		
05221-6002	BOARD ASSY:AMPLIFIER/TRIGGER	28480	05221-6002			1
05221-6010	BOARD ASSY:POWER SUPPLY	28480	05221-6010	1		1
05221-6011	BOARD ASSY:OSCILLATOR/TIME BASE	28480	05221-6011	1		1
05221-6012	BOARD ASSY:AMPLIFIER/TRIGGER	28480	05221-6012	1		

 # See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont'd)

℗ Part No.	Description #	Mfr.	Mfr. Part No.	TQ		
				5221		5321
05221-6013	BOARD ASSY:COUNTER	28480	05221-6013	1		
05221-6014	CABLE ASSY:MAIN	28480	05221-6014	1		
05221-6015	CABLE ASSY:POWER	28480	05221-6015	1		
05221-6016	CABLE ASSY:SAMPLE RATE	28480	05221-6016	1		
05221-6025	SWITCH ASSY:ATTENUATOR	28480	05221-6025	1		
05321-00001	CHASSIS:POWER SUPPLY	28480	05321-00001			1
05321-00004	CHASSIS:MAIN	28480	05321-00004			1
05321-00005	BRACKET:TIME BASE BOARD	28480	05321-00005			1
05321-00006	BRACKET:POWER SUPPLY BOARD	28480	05321-00006			1
05321-20001	BOARD:BLANK PC	28480	05321-20001			1
05321-40001	WINDOW	28480	05321-40001			1
05321-60001	BOARD ASSY:COUNTER	28480	05321-60001			1
05321-60002	CABLE ASSY:AMPLIFIER OUTPUT	28480	05321-60002			1
05321-60003	CABLE ASSY:POWER	28480	05321-60003			1
05321-60004	CABLE ASSY:RF INPUT	28480	05321-60004			1
05321-60005	CABLE ASSY:TIME BASE	28480	05321-60005			1
05321-60006	CABLE ASSY:COUNTER BOARD	28480	05321-60006			1
05321-60007	CABLE ASSY:ATTEN/GATE SELECTOR	28480	05321-60007			1
05321-60009	SWITCH ASSY:ATTEN/GATE SELECTOR	28480	05321-60009			1

 # See introduction to this section for ordering information

Table 6-3. Code List of Manufacturers

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address
00000	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00287	Cemco Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
00348	Microtron Co., Inc.	Valley Stream, N.Y.
00373	Garlock Inc.	Cherry Hill, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp. Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S.C.
00866	Goe Engineering Co.	City of Industry, Cal.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
00929	Microlab Inc.	Livingston, N.J.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N.Y.
01009	Alden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors, Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01930	Amerock Corp.	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02116	Wheelock Signals, Inc.	Long Branch, N.J.
02286	Cole Rubber and Plastics Inc.	Sunnyvale, Calif.
02660	Amphenol-Borg Electronics Corp.	Chicago, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E. Semiconductor Prod. Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	Compton, Calif.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N.J.
03954	Singer Co., Diehl Div. Finderne Plant	Sumerville, N.J.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertville, N.J.
04062	Arco Electronic Inc.	Great Neck, N.Y.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04354	Precision Paper Tube Co.	Wheeling, Ill.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P.M. Motor Company	Westchester, Ill.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05277	Westinghouse Electric Corp. Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05397	Union Carbide Corp., Linde Div., Kemet Dept.	Cleveland, Ohio
05593	Illumitronic Engineering Co.	Sunnyvale, Calif.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05729	Metro-Tel Corp.	Westbury, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., Div. of Stewart Warner Corp.	Bridgeport, Conn.
06090	Raychem Corp.	Redwood City, Calif.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago, Ill.
06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N.Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Semcor Div. Components Inc.	Phoenix, Ariz.
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
06980	Varian Assoc. Eimac Div.	San Carlos, Calif.
07088	Kelvin Electric Co.	Van Nuys, Calif.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Calif.
07261	Avnet Corp.	Culver City, Calif.
07263	Fairchild Camera & Inst. Corp. Semiconductor Div.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Birtcher Corp., The	Monterey Park, Calif.
07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Calif.
07700	Technical Wire Products Inc.	Cranford, N.J.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Calif.
07980	Hewlett-Packard Co., Boonton Radio Div.	Rockaway, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08289	Blinn, Delbert Co.	Pomona, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08524	Deutsch Fastener Corp.	Los Angeles, Calif.
08664	Bristol Co., The	Waterbury, Conn.
08717	Sloan Company	Sun Valley, Calif.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08792	CBS Electronics Semiconductor Operations, Div of C.B.S. Inc.	Lowell, Mass.
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Tech. Ind. Inc. Atohm Elect.	Burbank, Calif.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc., Microwave Div.	Palo Alto, Calif.
11314	National Seal	Downey, Calif.
11534	Duncan Electronics Inc.	Costa Mesa, Calif.
11711	General Instrument Corp., Semiconductor Div., Products Group	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12136	Philadelphia Handle Co.	Camden, N.J.
12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
12574	Gulton Ind. Inc. Data System Div.	Albuquerque, N.M.
12697	Clarostat Mfg. Co.	Dover, N.H.
12728	Elmar Filter Corp.	W. Haven, Conn.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12881	Metex Electronics Corp.	Clark, N.J.
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13103	Thermolloy	Dallas, Texas
13396	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp.	West Palm Beach, Fla.
14493	Hewlett-Packard Company	Loveland, Colo.
14655	Cornell Dublier Electric Corp.	Newark, N.J.
14674	Corning Glass Works	Corning, N.Y.
14752	Electro Cube Inc.	San Gabriel, Calif.
14960	Williams Mfg. Co.	San Jose, Calif.
15203	Webster Electronics Co.	New York, N.Y.
15287	Scionics Corp.	Northridge, Calif.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15558	Micron Electronics	Garden City, Long Island, N.Y.
15566	Amprobe Inst. Corp.	Lynbrook, N.Y.
15631	Cabletronics	Costa Mesa, Calif.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15801	Fenwal Elect. Inc.	Framingham, Mass.
15818	Amelco Inc.	Mt. View, Calif.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16179	Omni-Spectra Inc.	Detroit, Ill.
16352	Computer Diode Corp.	Lodi, N.J.
16688	Ideal Prec. Meter Co., Inc. De Jur Meter Div.	Brooklyn, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokoma, Ind.
17109	Thermonetics Inc.	Canoga Park, Calif.
17474	Tranex Company	Mountain View, Calif.
17675	Hamlin Metal Products Corp.	Akron, Ohio
17745	Angstrohm Prec. Inc.	No. Hollywood, Calif.
17870	McGraw-Edison Co.	Manchester, N.H.
18042	Power Design Pacific Inc.	Palo Alto, Calif.
18083	Clevite Corp., Semiconductor Div.	Palo Alto, Calif.
18324	Signetics Corp.	Sunnyvale, Calif.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	The Bendix Corp., Navigation & Control Div.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19589	Concoa	Baldwin Park, Calif.
19644	LRC Electronics	Horseheads, N.Y.
19701	Electra Mfg. Co.	Independence, Kansas

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Table 6-3. Code List of Manufacturers (Cont'd)

Code No.	Manufacturer	Address
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N.Y.
21335	Fafnir Bearing Co., The	New Britain, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23783	British Radio Electronics Ltd.	Washington, D.C.
24455	G.E. Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
24681	Memcor Inc., Comp. Div.	Huntington, Ind.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products Ltd.	Hawkesbury, Ontario, Canada
36287	Cunningham, W.H. & Hill, Ltd.	Toronto Ontario, Canada
37942	P.R. Mallory & Co. Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.
52090	Rowan Controller Co.	Westminster, Md.
52983	Sanborn Company	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & Systems Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex Corp.	Tulsa, Okla.
59730	Thomas & Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark	Newark, N.J.
66295	Wiltek Mfg. Co.	Chicago, Ill.
66346	Minnesota Mining & Mfg. Co. Revere Mincom Div.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control	New York, N.Y.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	Union City, N.J.
70674	ADC Products Inc.	Minneapolis, Minn.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Calif.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Calif.
71471	Cinema, Div. Aerovox Corp.	Burbank, Calif.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72699	General Instrument Corp., Cap. Div.	Newark, N.J.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Technological Products, Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Elect Co.	Hicksville, L.I., N.Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73586	Circle F Mfg. Co.	Trenton, N.J.
73682	George K. Garrett Co., Div. MSL Industries Inc.	Philadelphia, Pa.
73734	Federal Screw Products Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Jose, Calif.
73957	Groov-Pin Corp.	Ridgefield, N.J.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75378	CTS Knights Inc.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif.
76433	General Instrument Corp., Micamold Division	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76703	National Union	Newark, N.J.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	The Bendix Corp., Electrodynamics Div.	N. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phanostran Instrument and Electronic Co.	South Pasadena, Calif.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77638	General Instrument Corp., Rectifier Div.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association. Any brand Tube meeting EIA Standards-Washington, DC.	
80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Controls Co.	Columbus, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Label Co.	Monrovia, Calif.
80583	Hammarlund Co., Inc.	New York, N.Y.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
81030	International Instruments Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	
81483	International Rectifier Corp.	El Segundo, Calif.
81541	Airpax Electronics, Inc.	Cambridge, Maryland
81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sperti Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp. Space & Defense System Div.	Paramus, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc. Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc. Spencer Products	Attleboro, Mass.
82768	Phillips-Advance Control Co.	Joliet, Ill.
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.

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Table 6-3. Code List of Manufacturers (Cont'd)

Code No.	Manufacturer	Address
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	General Instrument Corp., Capacitor Div.	Darlington, S.C.
83148	ITT Wire and Cable Div.	Los Angeles, Calif.
83186	Victory Eng. Corp:	Springfield, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83332	Tech Labs	Palisade's Park, N.J.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co. Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp. Electronic Tube Div.	Plainfield, N.J.
83740	Union Carbide Corp. Consumer Prod. Div.	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
83942	Aeronautical Inst. & Radio Co.	Lodi, N.J.
84171	Arco Electronics Inc.	Great Neck, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Calif.
84411	TRW Capacitor Div.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A.B. Boyd Co.	San Francisco, Calif.
85474	R.M. Bracamonte & Co.	San Francisco, Calif.
85660	Koiled Kords, Inc.	Hamden, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, Electronic Comp. & Devices Div.	Harrison, N.J.
87034	Marco Industries	Anaheim, Calif.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
87664	Van Waters & Rogers Inc.	San Francisco, Calif.
87930	Tower Mfg. Corp.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Calif.
89473	G.E. Distributing Corp.	Schenectady, N.Y.
89665	United Transformer Co.	Chicago, Ill.
90179	US Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91146	ITT Cannon Elect, Inc., Salem Div.	Salem, Mass.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Willow Grove, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Calif.
91886	Malco Mfg. Co., Inc.	Chicago, Ill.
91929	Honeywell Inc., Micro Switch Div.	Freeport, Ill.
91961	Nahm-Bros. Spring Co.	Oakland, Calif.
92180	Tru-Connector Corp.	Peabody, Mass.
92367	Elgeet Optical Co. Inc.	Rochester, N.Y.
92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N.Y.
92702	IMC Magnetics Corp.	Wesbury Long Island, N.Y.
92966	Hudson Lamp Co.	Kearney, N.J.
93332	Sylvania Electric Prod. Inc. Semiconductor Div.	Woburn, Mass.
93369	Robbins & Myers Inc.	Palisades Park, N.J.
93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio
93929	G.V. Controls	Livingston, N.J.
94137	General Cable Corp.	Bayonne, N.J.
94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	Quincy, Mass.
94148	Scientific Electronics Products, Inc.	Loveland, Colo.
94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N.J.
94197	Curtiss-Wright Corp. Electronics Div.	East Paterson, N.J.
94222	South Chester Corp.	Chester, Pa.
94330	Wire Cloth Products, Inc.	Bellwood, Ill.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
94696	Magnecraft Electric Co.	Chicago, Ill.
95023	George A. Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.,	Dania, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	Long Island, N.Y.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Rolling Meadows, Ill.
95566	Arnold Engineering Co.	Marengo, Ill.
95712	Dage Electric Co., Inc.	Franklin, Ind.
95984	Siemon Mfg. Co.	Wayne, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Huggins Laboratories	Sunnyvale, Calif.
96095	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
96256	Thordarson-Meissner Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic & Precision Mfg.	Englewood, N.J.
97979	Reon Resistor Corp.	Yonkers, N.Y.
97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N.Y.
98141	R-Troncis, Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Calif.
98220	Hewlett-Packard Co., Moseley Div.	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98376	Zero Mfg. Co.	Burbank, Calif.
98731	General Mills Inc., Electronics Div.	Minneapolis, Minn.
98734	Paeco Div. of Hewlett-Packard Co.	Palo Alto, Calif.
98821	North Hills Electronics, Inc.	Glen Cove, N.Y.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99378	Atlee Corp.	Winchester, Mass.
99515	Marshall Ind., Capacitor Div.	Monrovia, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Electronics Corp. Semiconductor Div.	El Monte, Calif.
99957	Technology Instrument Corp. of Calif.	Newbury Park, Calif.

THE FOLLOWING HP VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.

0000F	Malco Tool and Die	Los Angeles, Calif.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AB	ETA	England
000BB	Precision Instrument Components Co.	Van Nuys, Calif.
000CS	Hewlett-Packard Co., Colorado Springs	Colorado Springs, Colorado
000MM	Rubber Eng. & Development	Hayward, Calif.
000NN	A "N" D Mfg. Co.	San Jose, Calif.
000QQ	Cooltron	Oakland, Calif.
000WW	California Eastern Lab.	Burlington, Calif.
000YY	S.K. Smith Co.	Los Angeles, Calif.

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SECTION VII

OPTIONS AND MANUAL CHANGES

7-1. OPTIONS

7-2. The Counters are available with Option 01, 6-digit display. Option 01 consists of the following additional components on counter board A4 (Figure 8-6): A4IC16, 17, 18, DS6, CR8, and R32. Option 01 information is listed in Table 7-1.

7-3. DIGITAL DISPLAY KIT

7-4. The parts required for Option 01 may be ordered as a kit. Parts for the display kit are listed in Table 7-2.

7-5. MANUAL CHANGES

7-6. Current Instruments

7-7. This manual applies directly to 5221B Counters with serial prefix 812 (refer to Paragraph 1-11).

7-8. Newer Instruments

7-9. As changes are made, newer instruments may have serial numbers not listed in this manual. The manuals for these instruments will be supplied with an additional "Manual Changes" sheet containing the required information. If this sheet is missing, contact the nearest Hewlett-Packard Sales and Service office for information.

Table 7-1. Options

Option	Description	HP Part No.
01 (5221B)	6-digit display	05221-6026
01 (5321B)	6-digit display	05321-60010

Table 7-2. Digital Display Kit

Description	HP Part No.	Req.No.
KIT, DIGIT DISPLAY	05221-6022	
Resistor, fxd, 20K ohm	0683-2035	1
Connector, Single Contact	1251-1556	11
Integrated Circuit	1820-0116	1
Integrated Circuit	1820-0092	1
Integrated Circuit	1820-0093	1
Diode	1901-0025	1
Tube, electron	1970-0025	1

SECTION VIII

CIRCUIT DIAGRAMS

8-1. This section includes the following:

a. General notes for schematic diagrams in Figure 8-1.

b. Schematic diagrams and component location illustrations of counter circuit board assemblies in the order of their assembly designation (A1 through A3, Figures 8-2 through 8-7). These figures may also include waveforms and voltages. Top and bottom views of integrated circuits are shown with pin numbers for identification.

8-2. The diagrams, when unfolded, can be used with other parts of the manual or when the manual is closed.

8-3. Dc voltages are measured with HP Model 412A DC Voltmeter. Typical voltages are shown.

8-4. Waveforms taken with HP Model 140A Oscilloscope with the HP 1402A and 1420A Vertical and Horizontal plug-ins. Oscilloscope vertical amplifier bandwidth is 20 MHz and is used with 10:1 divider probe, HP 10001A.

8-5. Shaded areas on the schematic diagrams indicate printed circuit assemblies. All components within the shaded areas are mounted on the boards.

Figure 8-1. Schematic Diagram Notes

SYMBOLS

FRONT PANEL

REAR PANEL

PANEL CONTROL

SCREWDRIVER ADJUST

WIPER MOVES TOWARD "CW" WHEN CONTROL IS ROTATED CLOCKWISE

POWER LINE GROUND

CIRCUIT COMMON GROUND

TEST POINT

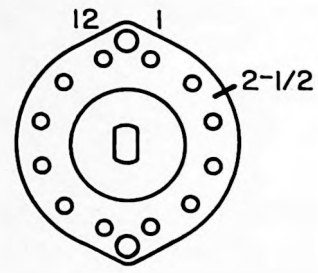
"AND" GATE

NAND GATE

WAVEFORMS SHOWN ARE TYPICAL

SWITCH DESIGNATIONS

A3S1BR(2-1/2)



A3S1 SWITCH S1 WITHIN ASSEMBLY A3

B 2ND WAFER FROM FRONT (A=1ST, ETC)

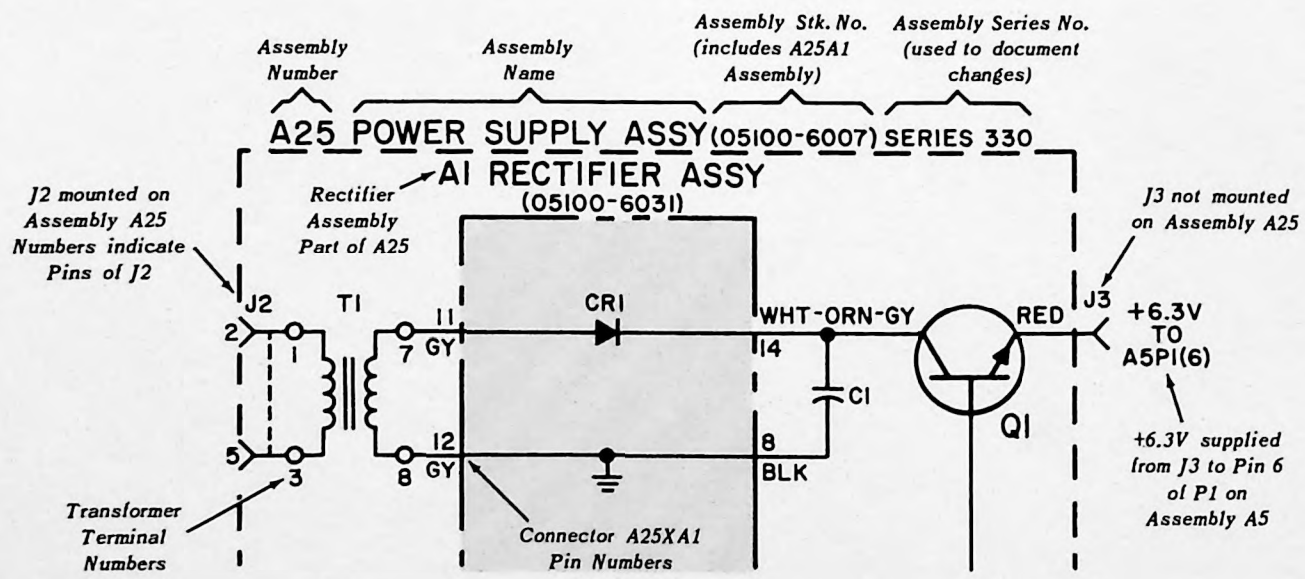
R REAR OF WAFER (F=FRONT)

(2-1/2) TERMINAL LOCATION ($2\frac{1}{2}$) (VIEWED FROM FRONT)

REFERENCE DESIGNATIONS

REFERENCE DESIGNATIONS WITHIN ASSEMBLIES ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.

ASSEMBLY	ABBREVIATION	COMPLETE DESCRIPTION
A25	C1	A25C1
A25A1	CR1	A25A1CR1
NO PREFIX	J3	J3



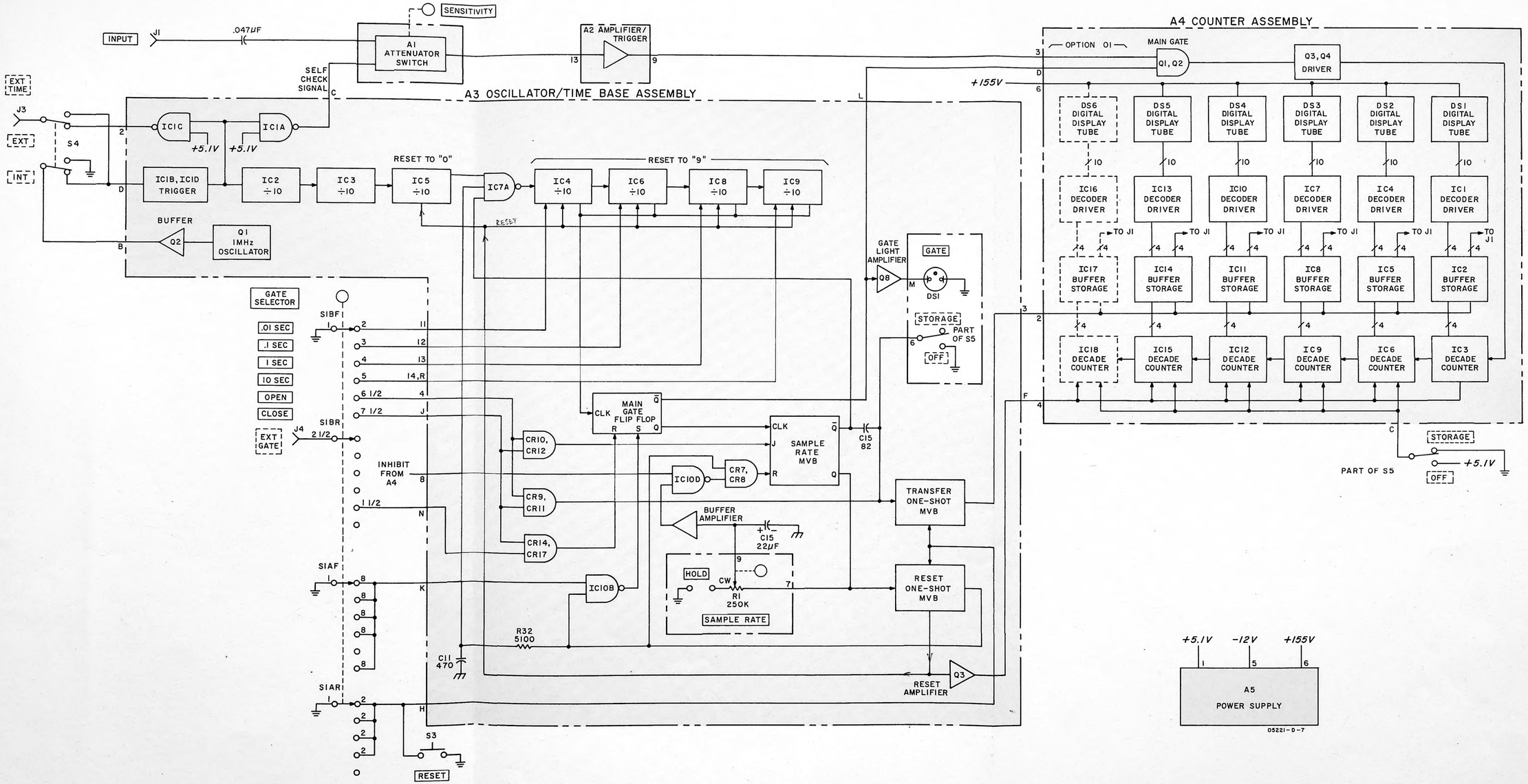
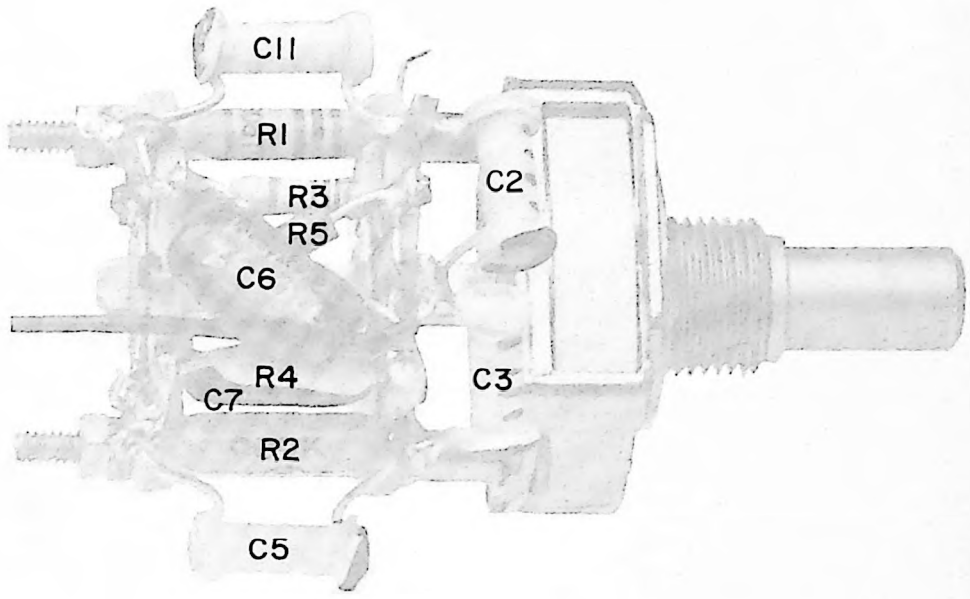
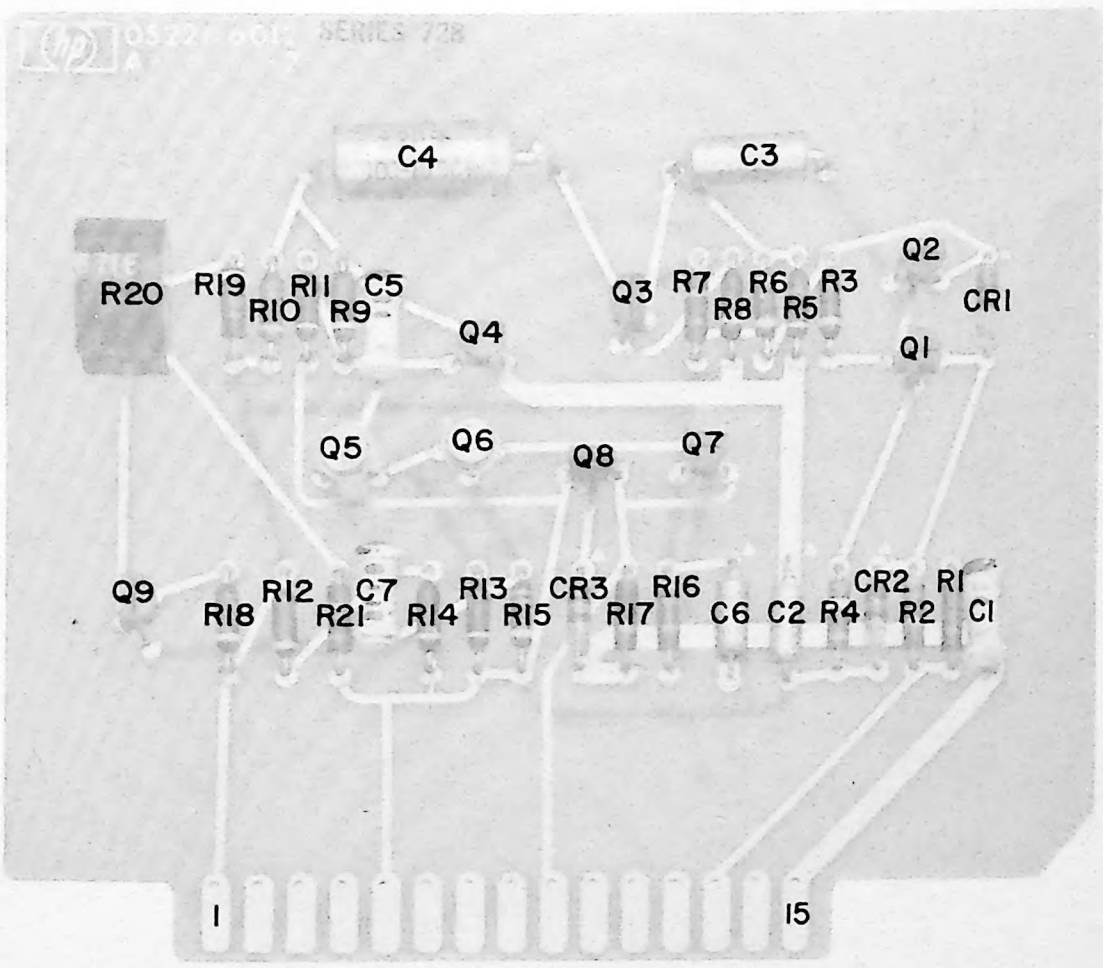
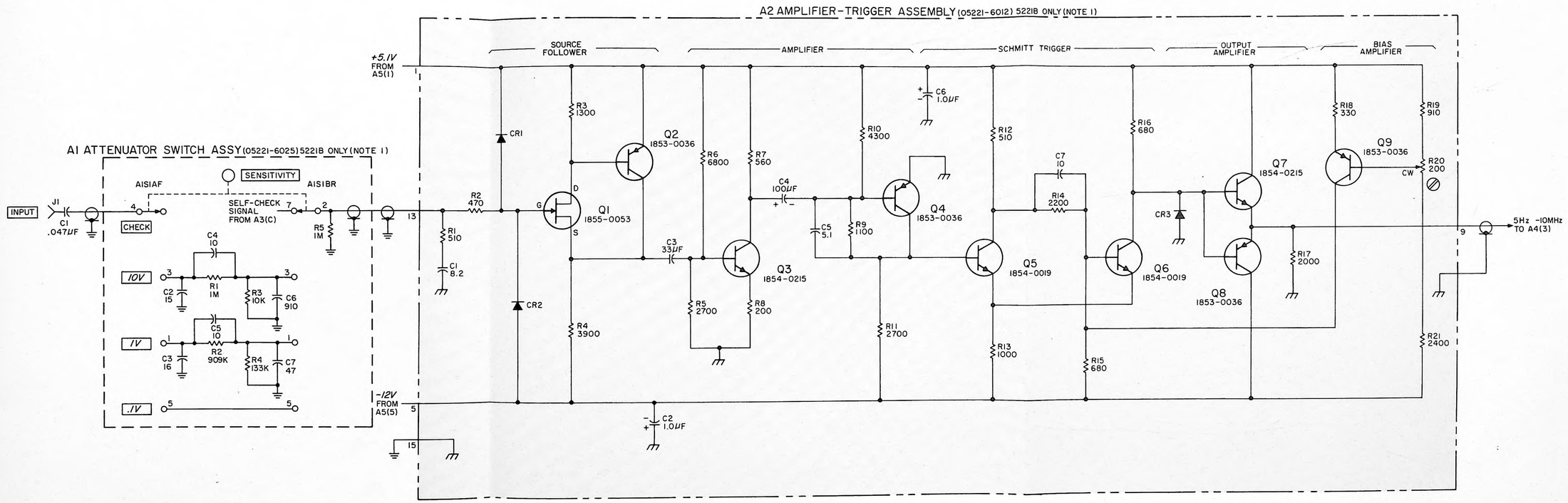


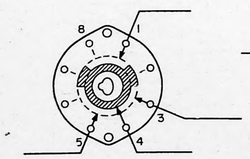
Figure 8-2. Block Diagram


C11
R1
R3
R5
C6
C2
R4
C7
C3
R2
C5

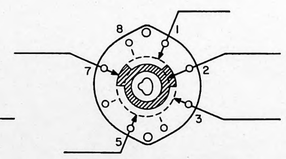

C4
C3
Q2
R20
R19
R11
C5
R10
R9
Q3
R7
R6
R3
R8
R5
CR1
Q4
Q1
Q5
Q6
Q8
Q7
Q9
R12
C7
R13
CR3
R16
CR2
R1
R18
R21
R14
R15
R17
C6
C2
R4
R2
C1
1
15



AISIAF



AISIBR



NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS;
   CAPACITANCE IN PICOFARADS;
3. SWITCHES SHOWN IN CCW POSITION AS VIEWED FROM FRONT OF INSTRUMENT

REFERENCE DESIGNATIONS

NO PREFIX	A1	A2
C1	C2-7	C1-7
		CR1-3
J1		Q1-9
	R1-5	R1-21
	S1	

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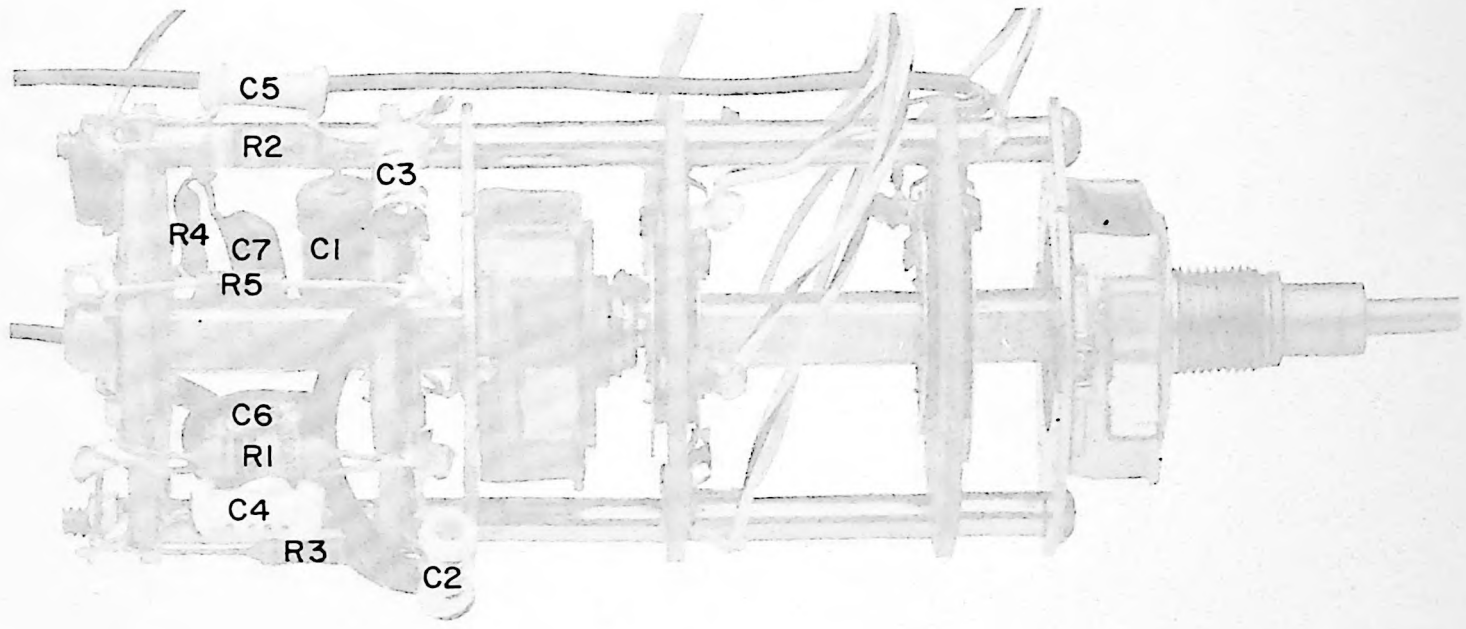
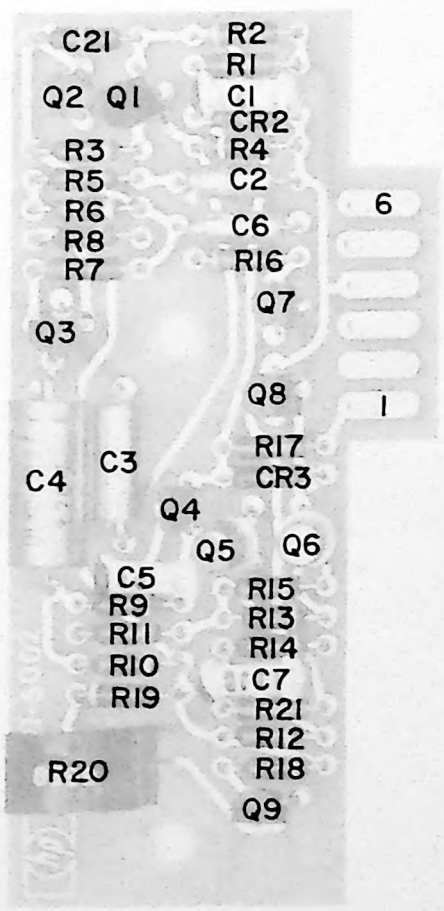
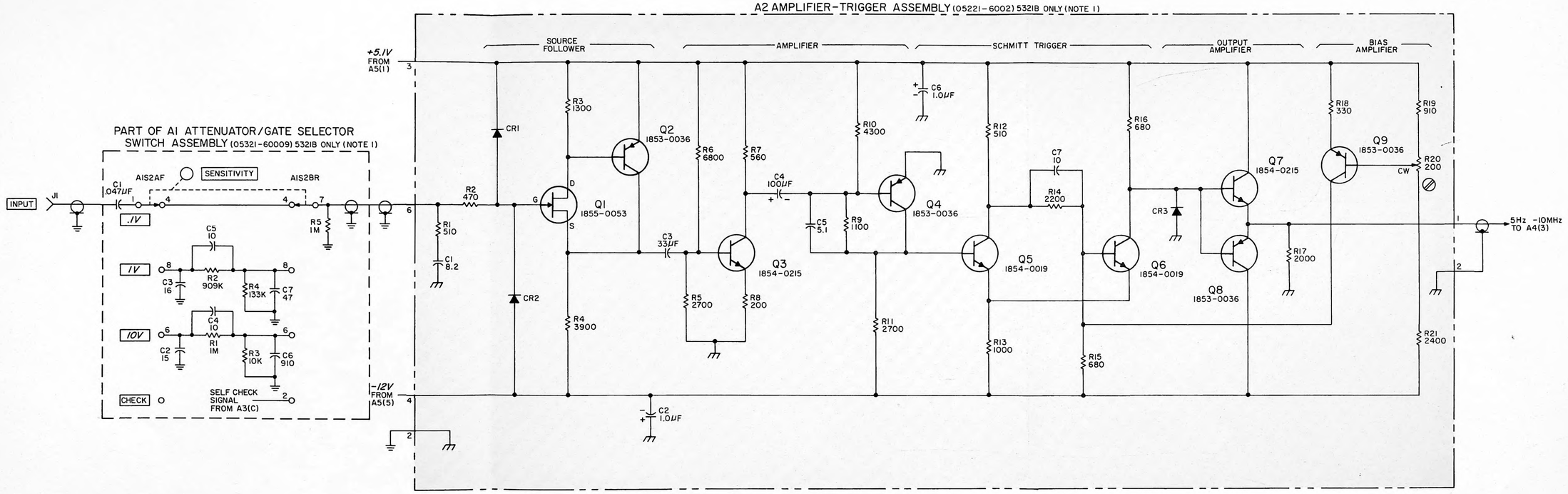
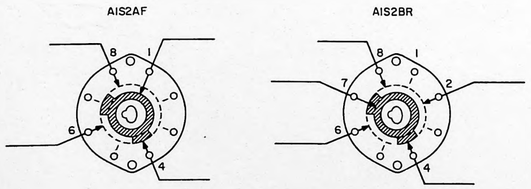
05221-D-8

Figure 8-3. A1 Input Attenuator (5221B)
A2 Amplifier-Trigger (5221B)


C5
R2
C3
R4
C7
C1
R5
C6
R1
C4
R3
C2


C21
R2
R1
Q2
Q1
C1
CR2
R3
R4
R5
C2
R6
6
C6
R8
R7
R16
Q7
Q3
Q8
1
R17
C3
C4
CR3
Q4
Q5
Q6
C5
R15
R9
R13
R11
R14
R10
C7
R19
R21
R12
R20
R18
Q9





NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS; CAPACITANCE IN PICOFARADS;
3. SWITCHES SHOWN IN CCW POSITION AS VIEWED FROM FRONT OF INSTRUMENT

REFERENCE DESIGNATIONS

NO PREFIX	A1	A2
J1	C1-7	C1-7 CR1-3
	R1-5 S2	Q1-9 R1-21

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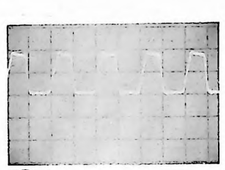
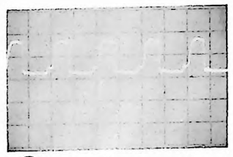
05221-D-9

Figure 8-4. A1 Attenuator-Gate Selector (5321B)
A2 Amplifier-Trigger (5321B)

Figure 8-4
A1 ATTENUATOR-GATE SELECTOR (5321B)
A2 AMPLIFIER-TRIGGER (5321B)

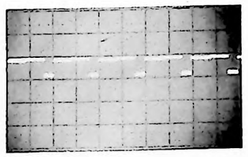


1 . 2V/cm + slope
. 5 μs/cm

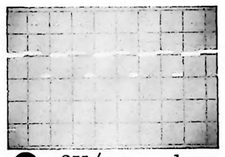


2 . 2V/cm + slope
. 5 μs/cm

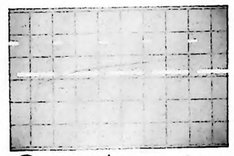
3 . 2V/cm + slope
5 μs/cm



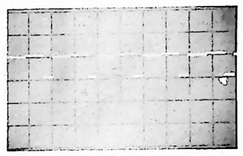
4 . 2V/cm + slope
50 μs/cm



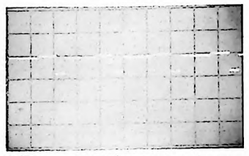
5 . 2V/cm + slope
. 5 ms/cm



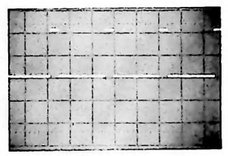
6 . 2V/cm + slope
. 5 ms /cm



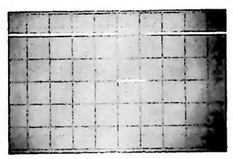
7 . 2V/cm + slope
5 ms/cm



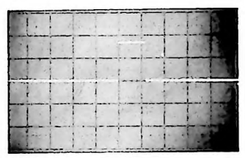
8 . 2V/cm + slope
50 ms/cm



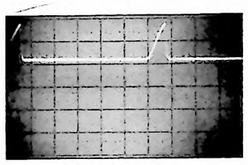
9 . 2V/cm + slope
50 ms/cm



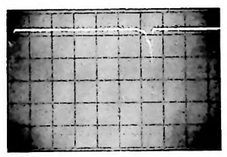
10 . 2V/cm + slope
20 ms/cm



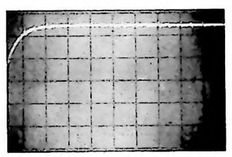
11 . 2V/cm - slope
20 ms/cm



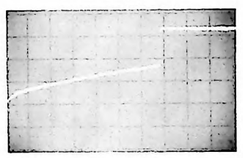
12 .05V/cm + slope
20 ms/cm



13 . 2V/cm - slope
20 ms/cm



14 . 1V/cm - slope
1 μs/cm

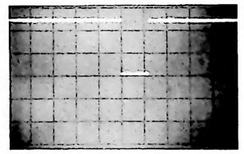


15 . 2V/cm + slope
. 5 μs/cm

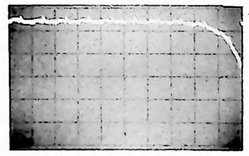
16 . 2V/cm + slope
1 μs/cm

17 . 2V/cm - slope
. 5 μs/cm

18 . 2V/cm - slope
5 μs/cm

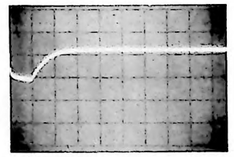


19 . 2V/cm + slope
20 ms/cm

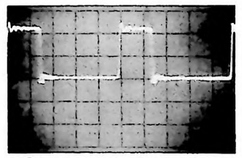


20 . 1V/cm - slope
1 μs/cm

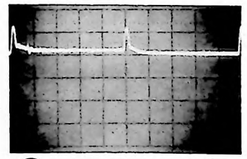
21 . 2V/cm + slope
2 μs/cm



22 . 1V/cm - slope
10 μs/cm



23 . 2V/cm + slope
. 2 μs/cm



24 .05V/cm + slope
. 2 μs/cm

Oscilloscope: All waveforms dc coupled through 10:1 divider probe. Center line of graticule is zero volts. Triggering is internal ac.

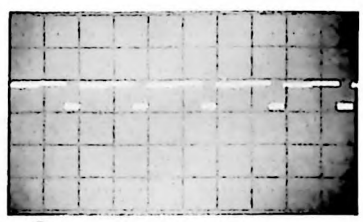
Counter:

SENSITIVITY . . . . . .1V with 1 MHz input
GATE SELECTOR . . . . . .1 sec
SAMPLE RATE . . . . . counterclockwise not OFF

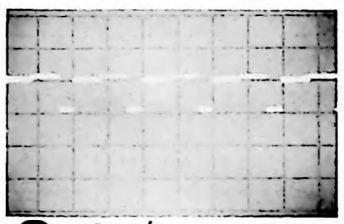
1 . 2V/cm + slope
. 5 μs/cm

2 . 2V/cm + slope
. 5 μs/cm

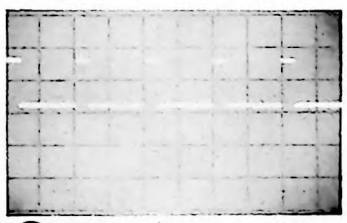
3 . 2V/cm + slope
5 μs/cm



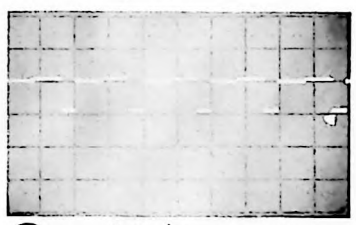
4 . 2V/cm + slope
50 μs/cm



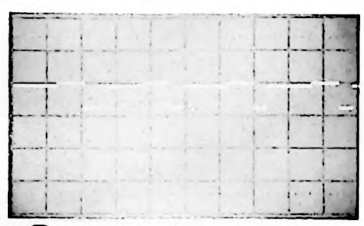
5 . 2V/cm + slope
. 5 ms/cm



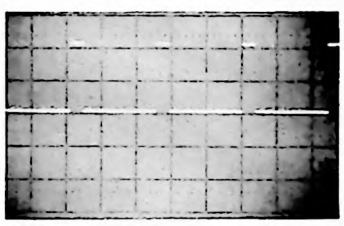
6 . 2V/cm + slope
. 5 ms /cm



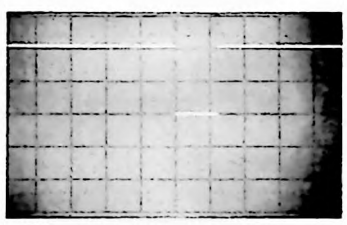
7 . 2V/cm + slope
5 ms/cm



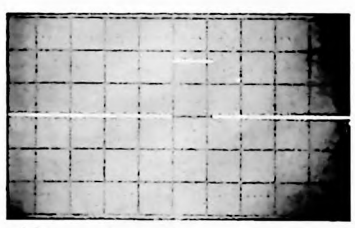
8 . 2V/cm + slope
50 ms/cm



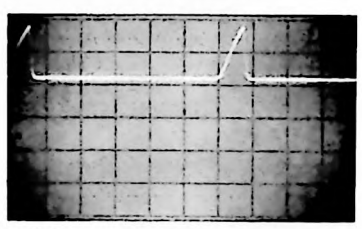
9 . 2V/cm + slope
50 ms/cm



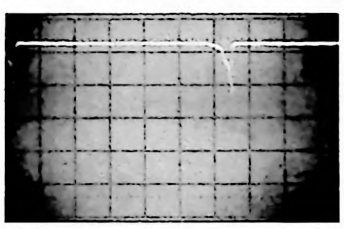
10 . 2V/cm + slope
20 ms/cm



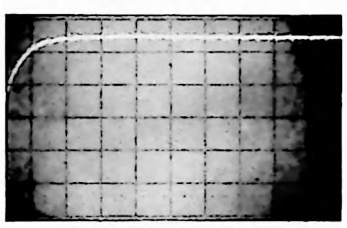
11 . 2V/cm - slope
20 ms/cm



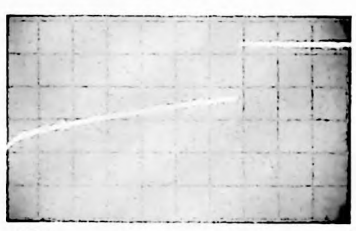
12 .05V/cm + slope
20 ms/cm



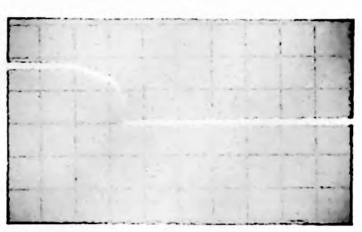
13 . 2V/cm - slope
20 ms/cm



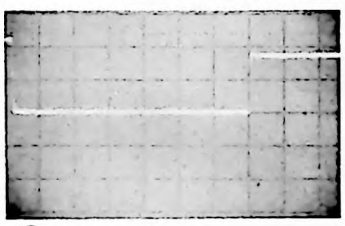
14 . 1V/cm - slope
1 μs/cm



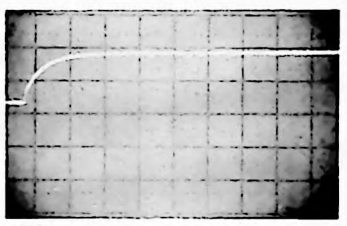
15 . 2V/cm + slope
. 5 μs/cm



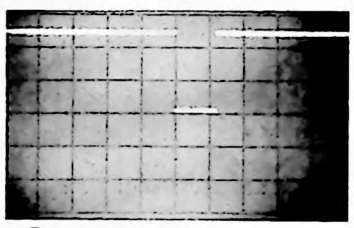
16 . 2V/cm + slope
1 μs/cm



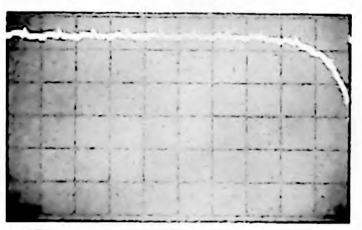
17 . 2V/cm - slope
. 5 μs/cm



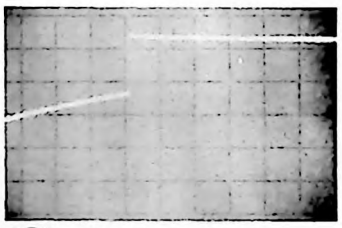
18 . 2V/cm - slope
5 μs/cm



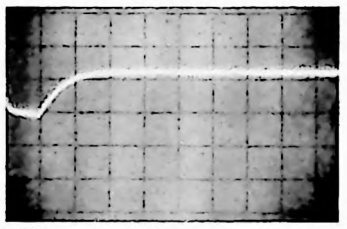
19 . 2V/cm + slope
20 ms/cm



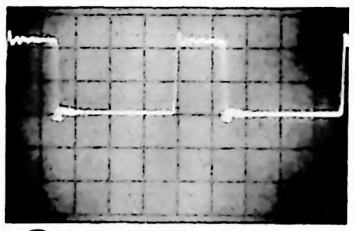
20 . 1V/cm - slope
1 μs/cm



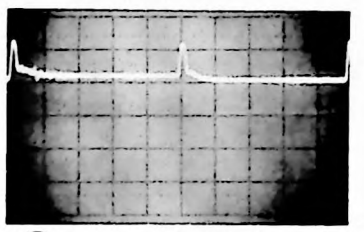
21 . 2V/cm + slope
2 μs/cm



22 . 1V/cm - slope
10 μs/cm



23 . 2V/cm + slope
. 2 μs/cm

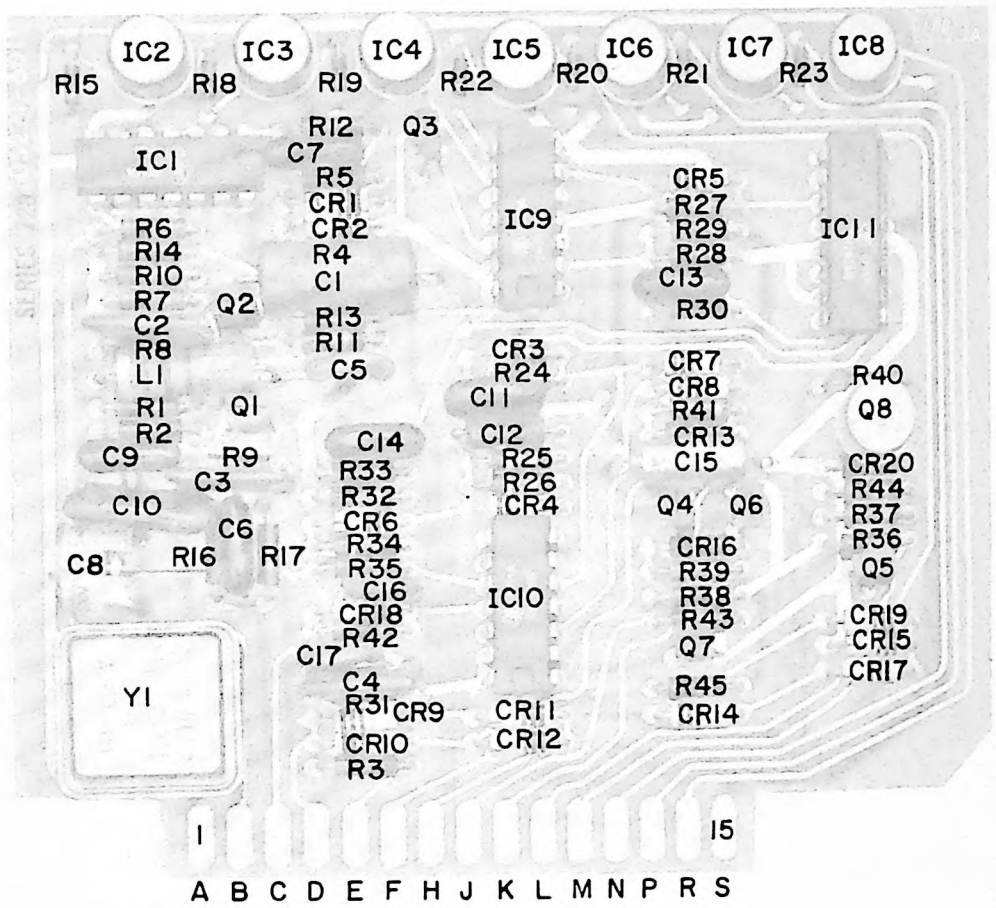


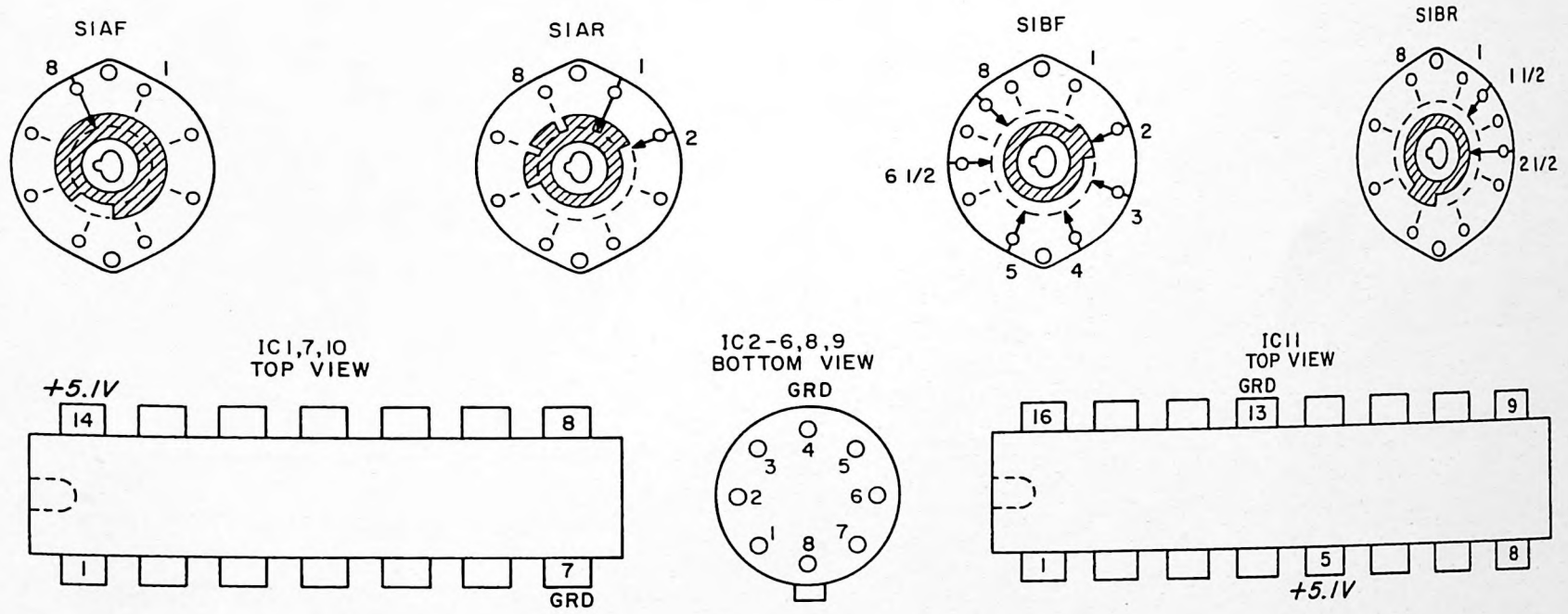
24 .05V/cm + slope
. 2 μs/cm

Oscilloscope: All waveforms dc coupled through 10:1 divider probe. Center line of graticule is zero volts. Triggering is internal ac.

Counter:

SENSITIVITY	.1V with 1 MHz input
GATE SELECTOR	.1 sec
SAMPLE RATE	counterclockwise not OFF





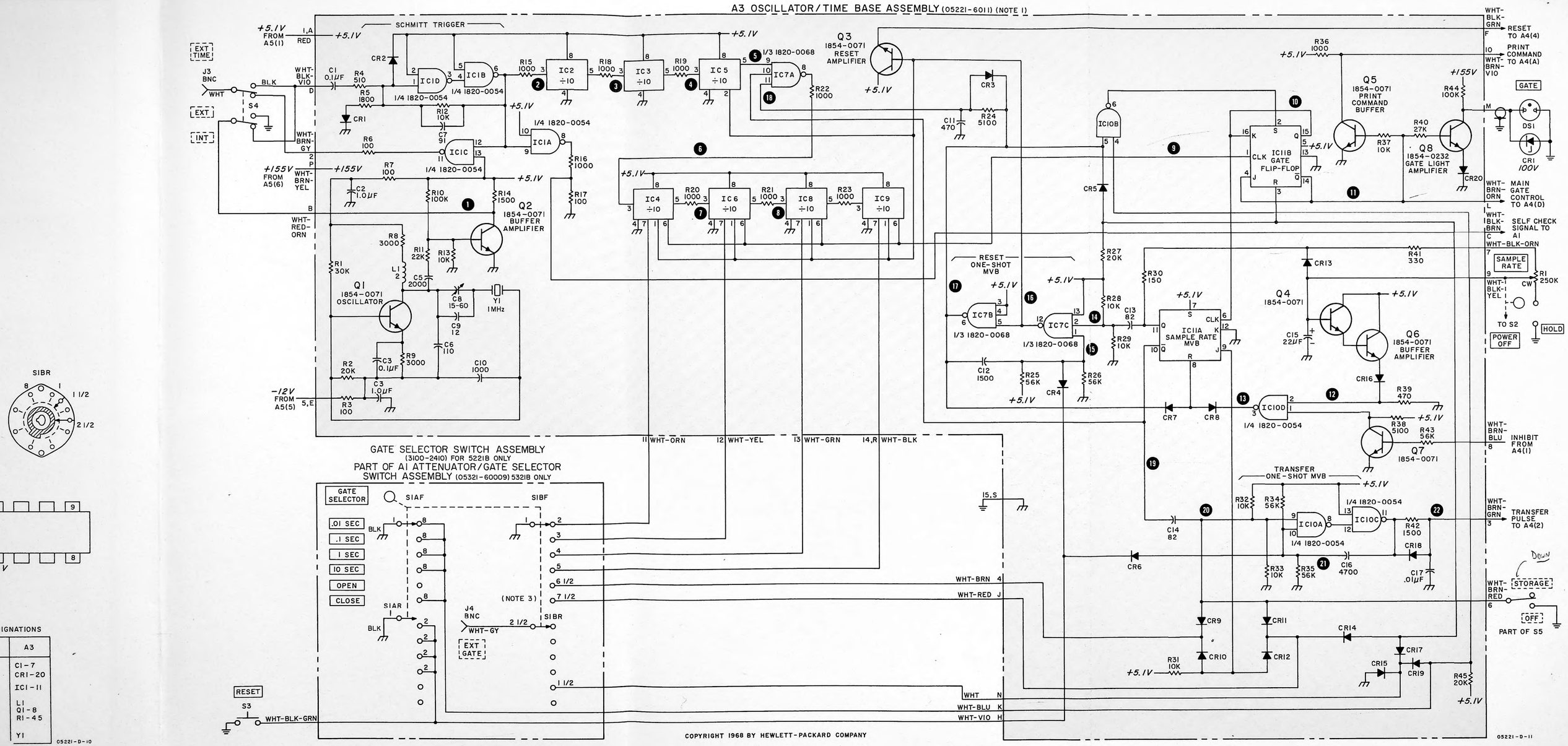
NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS;
   CAPACITANCE IN PICOFARADS;
   INDUCTANCE IN MICROHENRIES
3. PINS 6 1/2 AND 7 1/2 OF SIBF ARE SHORTED IN THE CLOSE POSITION

REFERENCE DESIGNATIONS

NO PREFIX	A1	A3
CR1 DS1 J3,4 R1 S3-5	S1	C1-7 CR1-20 IC1-11 L1 Q1-8 R1-45 Y1

05221-0-10

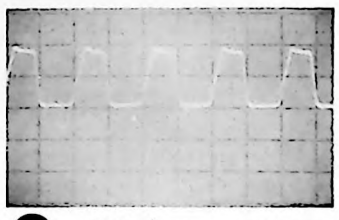


IGNATIONS

	A3
	C1-7
	CR1-20
	IC1-11
	L1
	Q1-8
	R1-45
	Y1

05221-D-10

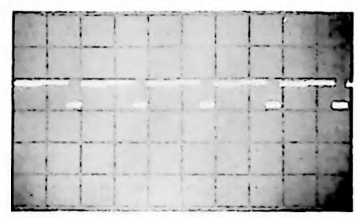
Figure 8-5. A3 Oscillator-Time Base



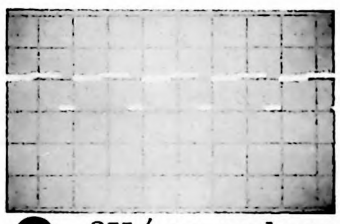
1 . 2V/cm + slope
. 5 μs/cm

2 . 2V/cm + slope
. 5 μs/cm

3 . 2V/cm + slope
5 μs/cm

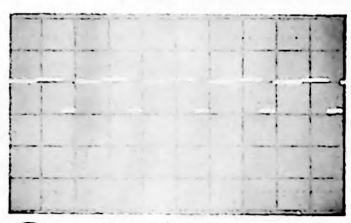


4 . 2V/cm + slope
50 μs/cm

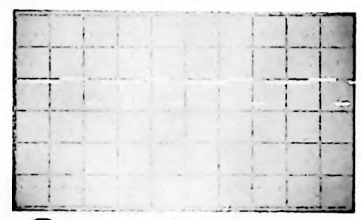


5 . 2V/cm + slope
. 5 ms/cm

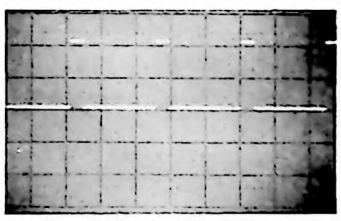
6 . 2V/cm + slope
. 5 ms /cm



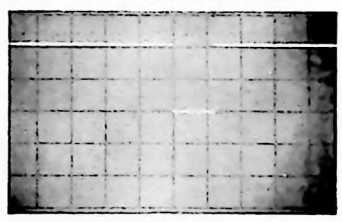
7 . 2V/cm + slope
5 ms/cm



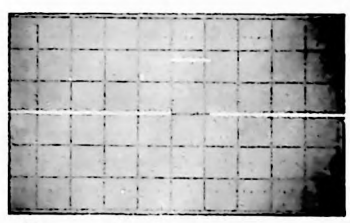
8 . 2V/cm + slope
50 ms/cm



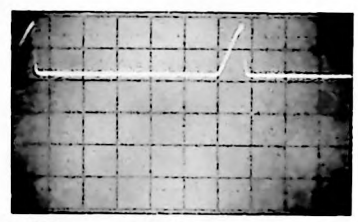
9 . 2V/cm + slope
50 ms/cm



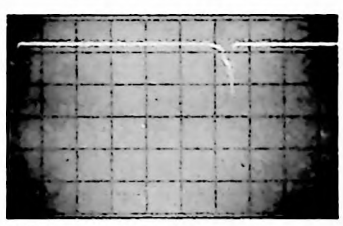
10 . 2V/cm + slope
20 ms/cm



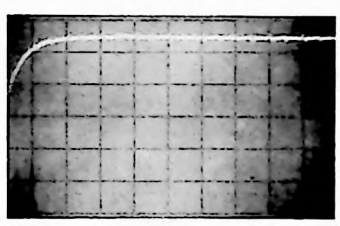
11 . 2V/cm - slope
20 ms/cm



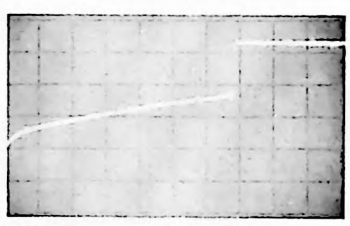
12 .05V/cm + slope
20 ms/cm



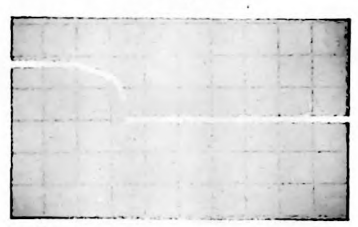
13 . 2V/cm - slope
20 ms/cm



14 . 1V/cm - slope
1 μs/cm

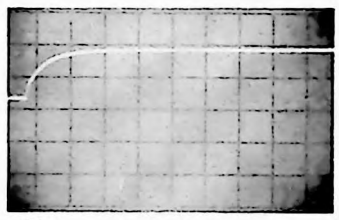


15 . 2V/cm + slope
. 5 μs/cm

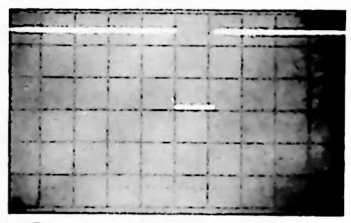


16 . 2V/cm + slope
1 μs/cm

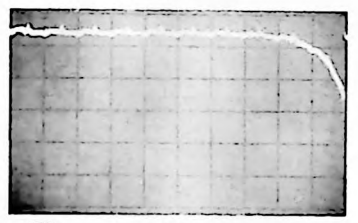
17 . 2V/cm - slope
. 5 μs/cm



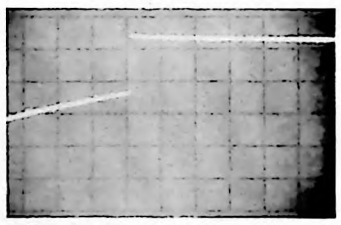
18 . 2V/cm - slope
5 μs/cm



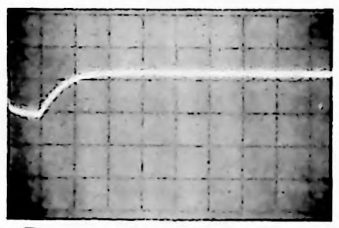
19 . 2V/cm + slope
20 ms/cm



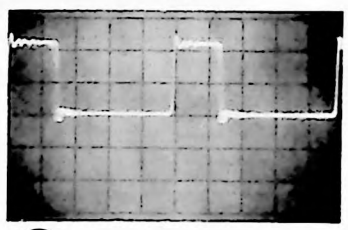
20 . 1V/cm - slope
1 μs/cm



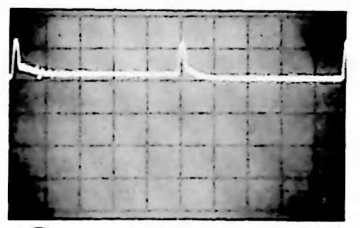
21 . 2V/cm + slope
2 μs/cm



22 . 1V/cm - slope
10 μs/cm



23 . 2V/cm + slope
. 2 μs/cm

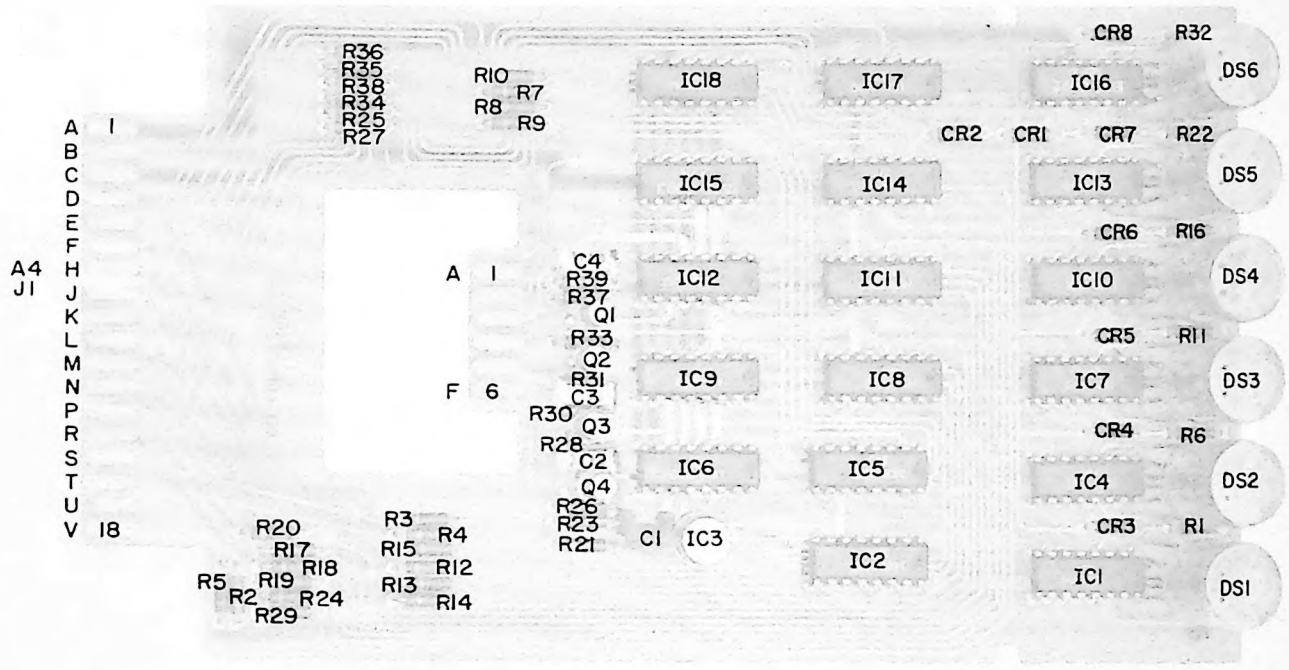


24 .05V/cm + slope
. 2 μs/cm

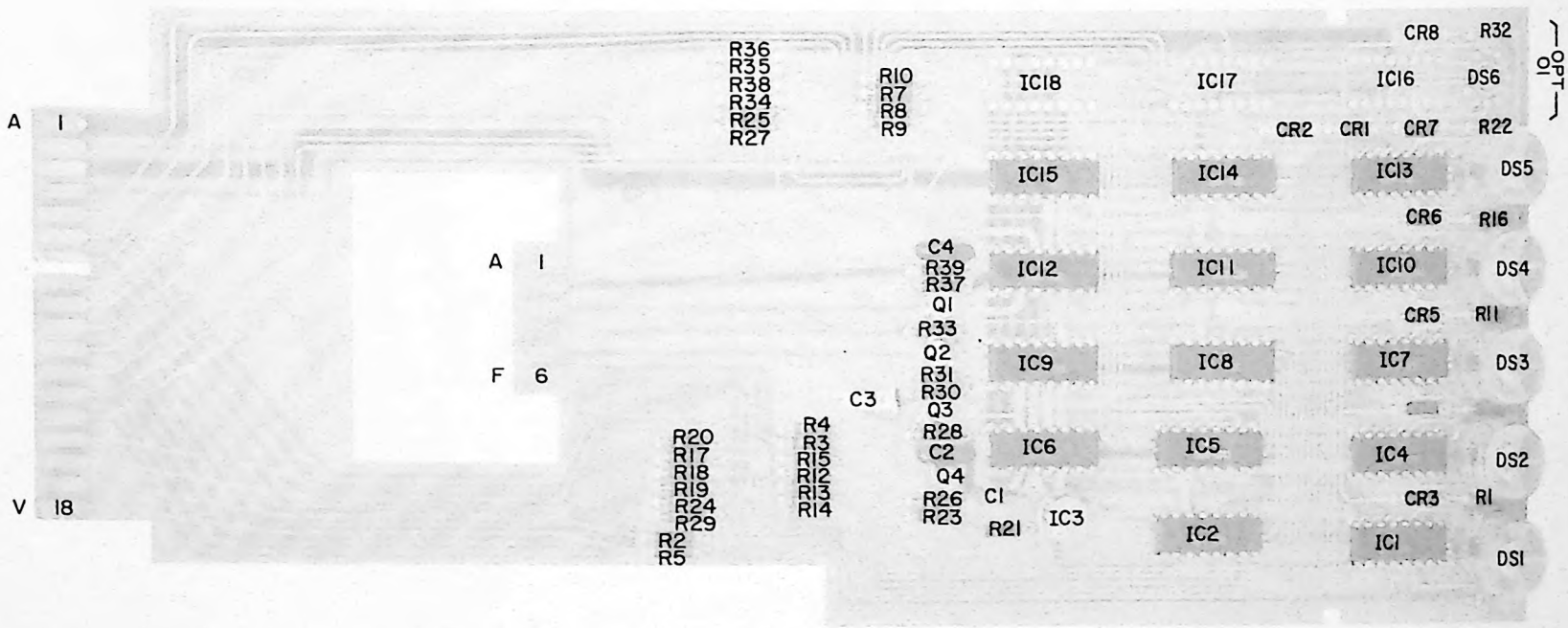
Oscilloscope: All waveforms dc coupled through 10:1 divider probe. Center line of graticule is zero volts. Triggering is internal ac.

Counter:

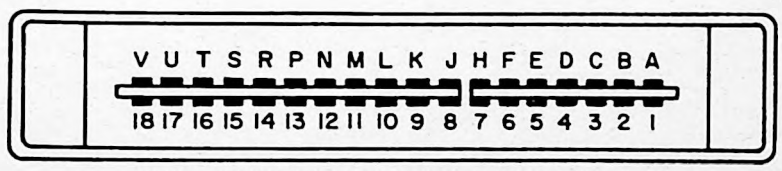
SENSITIVITY	.1V with 1 MHz input
GATE SELECTOR	.1 sec
SAMPLE RATE	counterclockwise not OFF



A4 (5221B)

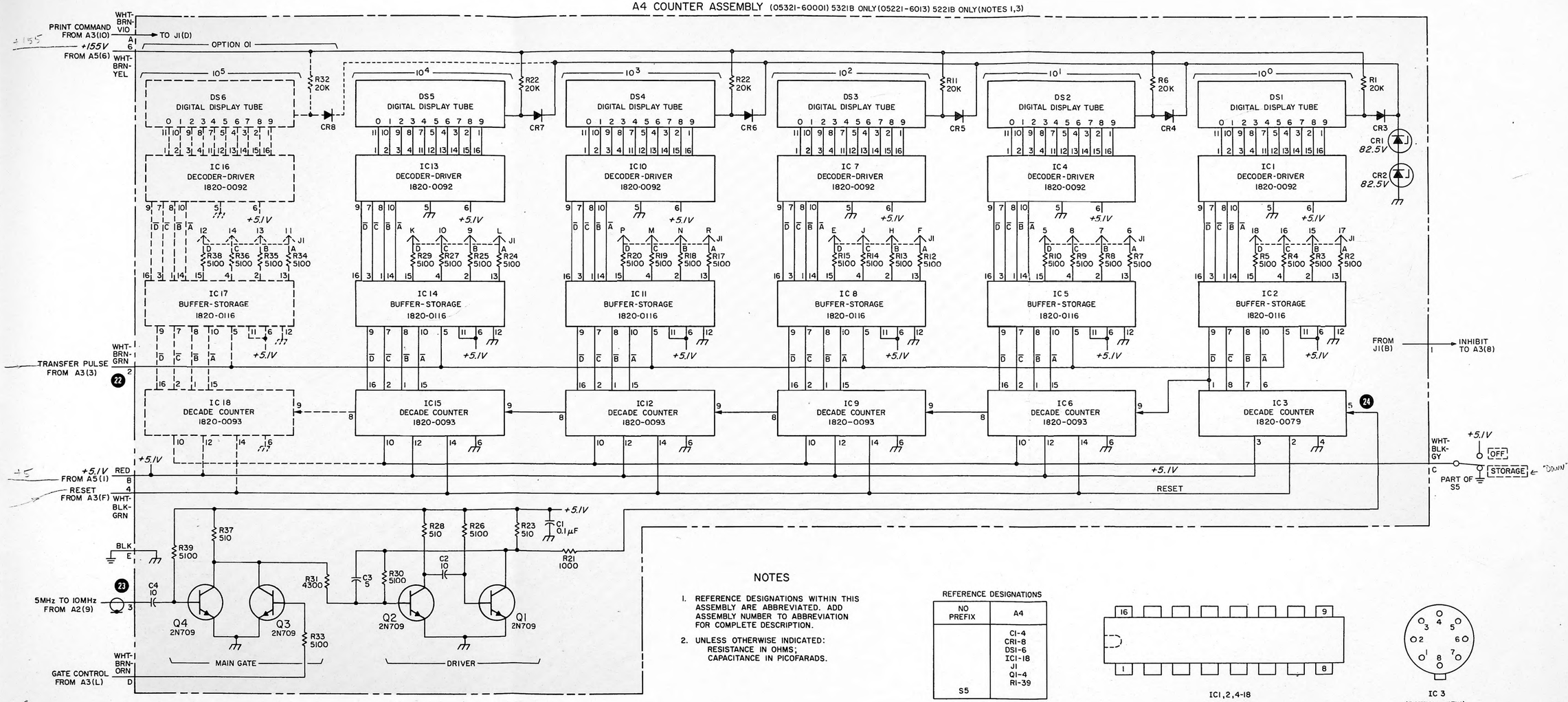


A4 (5231B)



A4J1 AS VIEWED FROM REAR OF COUNTER

A4 COUNTER ASSEMBLY (05321-60001) 5321B ONLY (05221-6013) 5221B ONLY (NOTES 1,3)



NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS; CAPACITANCE IN PICOFARADS.

REFERENCE DESIGNATIONS

NO PREFIX	A4
	C1-4
	CR1-8
	DS1-6
	IC1-18
	J1
	Q1-4
	R1-39
S5	

IC1,2,4-18 (TOP VIEW)

IC 3 (BOTTOM VIEW)

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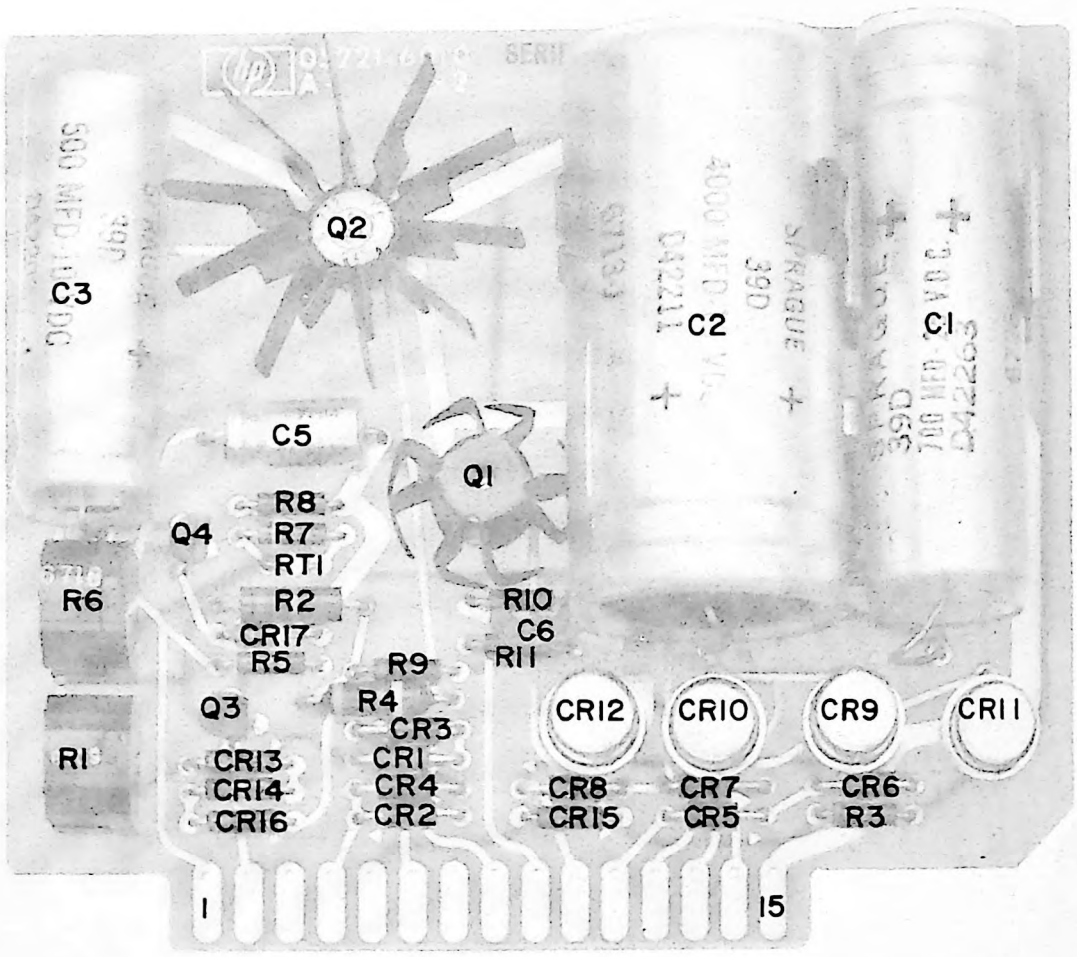
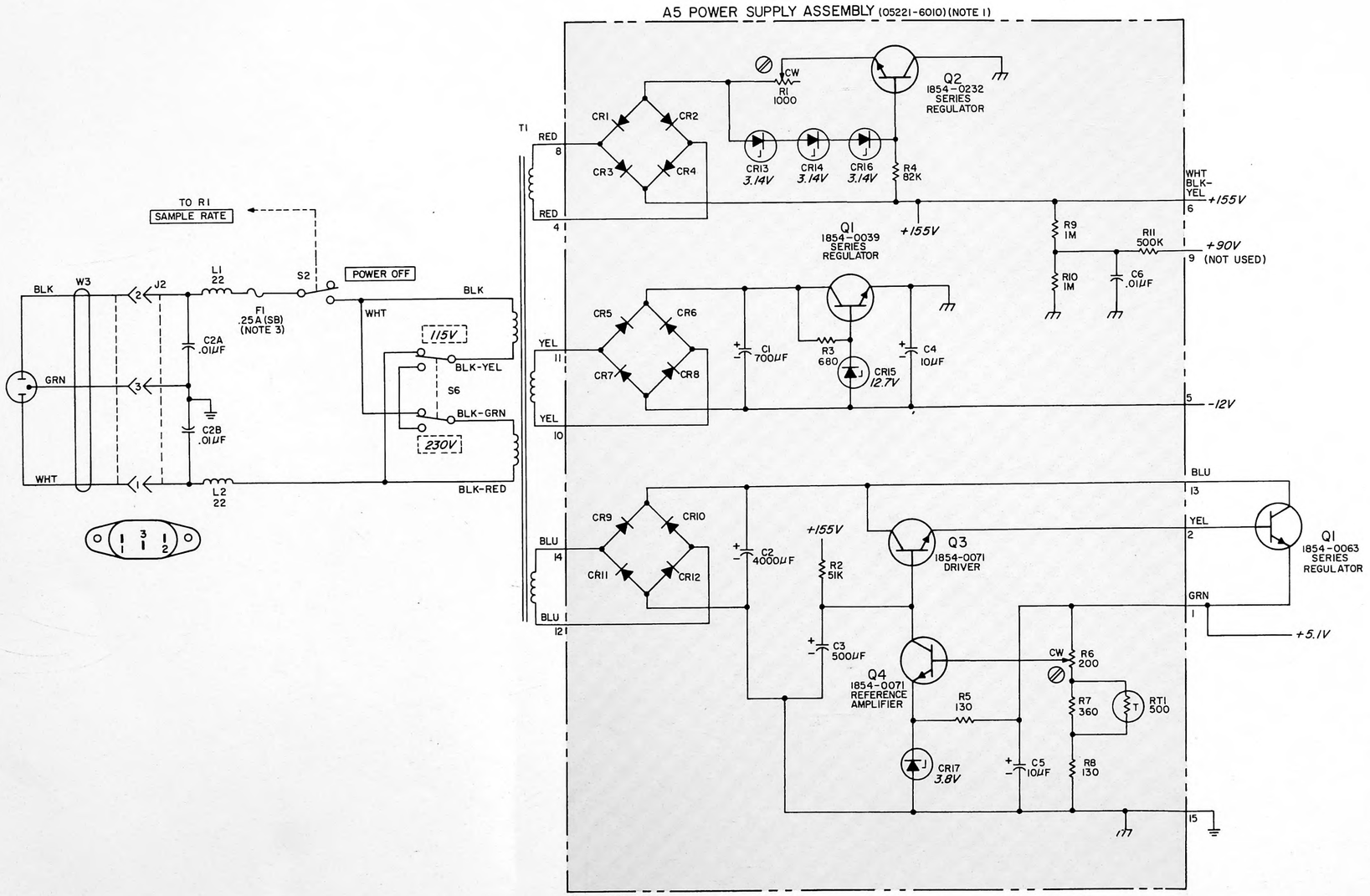
05221-D-12

Figure 8-6. A4 Counter Board


Q2
C3
C5
Q1
R8
Q4
R7
RT1
R6
R2
R10
C6
CR17
R5
R11
R9
Q3
R4
CR3
CR12
CR10
CR9
CR11
R1
CR13
CR1
CR14
CR4
CR8
CR7
CR6
CR16
CR2
CR15
CR5
R3
1
15
C2
C1

02494-1



NOTES

1. REFERENCE DESIGNATIONS WITHIN THIS ASSEMBLY ARE ABBREVIATED. ADD ASSEMBLY NUMBER TO ABBREVIATION FOR COMPLETE DESCRIPTION.
2. UNLESS OTHERWISE INDICATED:
   RESISTANCE IN OHMS;
   CAPACITANCE IN PICOFARADS;
   INDUCTANCE IN MICROHENRIES
3. FOR 230V OPERATION:
   SWITCH S6 TO 230V POSITION
   CHANGE F1 TO .15A (SB)

REFERENCE DESIGNATIONS

NO PREFIX	A5
C2	C1-6 CR1-17
F1	
J2	
L1,2	
Q1	Q1-4
	R1-11
S2,6	RT1
T1	
W3	

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05221-D-13

Figure 8-7. A4 Power Supply

HEWLETT · PACKARD

ELECTRONIC INSTRUMENTATION SALES AND SERVICE

UNITED STATES, CENTRAL AND SOUTH AMERICA, CANADA

UNITED STATES

ALABAMA
P.O. Box 4207
2003 Byrd Spring Road S.W.
Huntsville 35802
Tel: (205) 881-4591
TWX: 810-726-2204

ARIZONA
3009 North Scottsdale Road
Scottsdale 85251
Tel: (602) 945-7601
TWX: 910-950-1282

5737 East Broadway
Tuscon 85716
Tel: (602) 298-2313
TWX: 910-952-1162

CALIFORNIA
3939 Lankershim Boulevard
North Hollywood 91604
Tel: (213) 877-1282
TWX: 910-499-2170

1101 Embarcadero Road
Palo Alto 94303
Tel: (415) 327-6500
TWX: 910-373-1280

2591 Carlsbad Avenue
Sacramento 95821
Tel: (916) 482-1463
TWX: 910-367-2092

1055 Shafter Street
San Diego 92106
Tel: (714) 223-8103
TWX: 910-335-2000

COLORADO
7965 East Prentice
Englewood 80110
Tel: (303) 771-3455
TWX: 910-935-0705

CONNECTICUT
508 Tolland Street
East Hartford 06108
Tel: (203) 289-9394
TWX: 710-425-3416

111 East Avenue
Norwalk 06851
Tel: (203) 853-1251
TWX: 710-468-3750

DELAWARE
3941 Kennett Pike
Wilmington 19807
Tel: (302) 655-6161
TWX: 510-666-2214

FLORIDA
P.O. Box 545
Suite 106
9999 N.E. 2nd Avenue
Miami Shores 33153
Tel: (305) 758-3626
TWX: 810-848-7262

P.O. Box 20007
Herndon Station 32814
621 Commonwealth Avenue
Orlando
Tel: (305) 841-3970
TWX: 810-850-0113

P.O. Box 8128
Madeira Beach 33708
410 150th Avenue
St. Petersburg
Tel: (813) 391-0211
TWX: 810-863-0366

GEORGIA
P.O. Box 28234
2340 Interstate Parkway
Atlanta 30328
Tel: (404) 436-6181
TWX: 810-766-4890

ILLINOIS
5500 Howard Street
Skokie 60076
Tel: (312) 677-0400
TWX: 910-223-3613

INDIANA
4002 Meadows Drive
Indianapolis 46205
Tel: (317) 546-4891
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